AERONAUTICAL ENGINEERING REVIEW

OCTOBER 1951

ANNUAL SUMMER MEETING ISSUE

Now!

BENDIX-PACIFIC POSITION LIGHT FLASHERS CONFORM TO THE NEW C. A. B. REGULATION SR36

Dated March 9, 1951

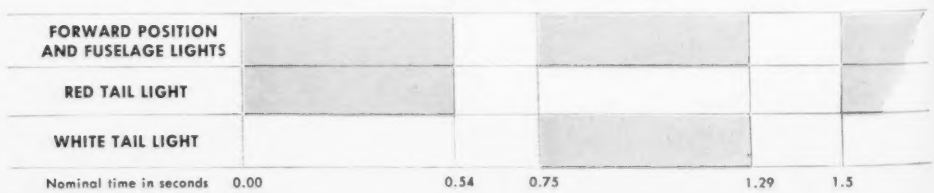
These dependable, light weight Position Light Flashers, which are in service on major airlines around the world, are now available with the new flashing cycle as illustrated below.

As in previous models, the new Bendix-Pacific Assembly 554230 incorporates a constant-speed, compound-wound ball bearing motor that assures accuracy of the flashing mechanism. Internal relay action also assures synchronization of fuselage and wing tip lights with either the red or white tail light. Relay contact points are designed to handle the increased current resulting from combining the forward position lights and fuselage lights in a common circuit.

Complete information will be gladly sent on request.

PRESENT FLASHING CYCLE

RECOMMENDED NEW FLASHING CYCLE



ATTENTION! *Owners of Bendix Flashers:*
Bendix-Pacific 450250-0-3 Flashers can readily be converted to conform to the new flashing schedule through the use of Bendix-Pacific kit #552490. For more information on this kit or other service parts contact Service Dept. at 117 E. Providencia, Burbank, Calif.

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Bendix Aviation Corporation

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Goodyear contributions to this outstanding new ship include fuel tanks and floor panels as well as tires, tubes, wheels and brakes. This new H-19 10-place helicopter, soon to be available commercially, has already proved itself on the Korean front, where it went into service late in March during the Munsan perimeter action.

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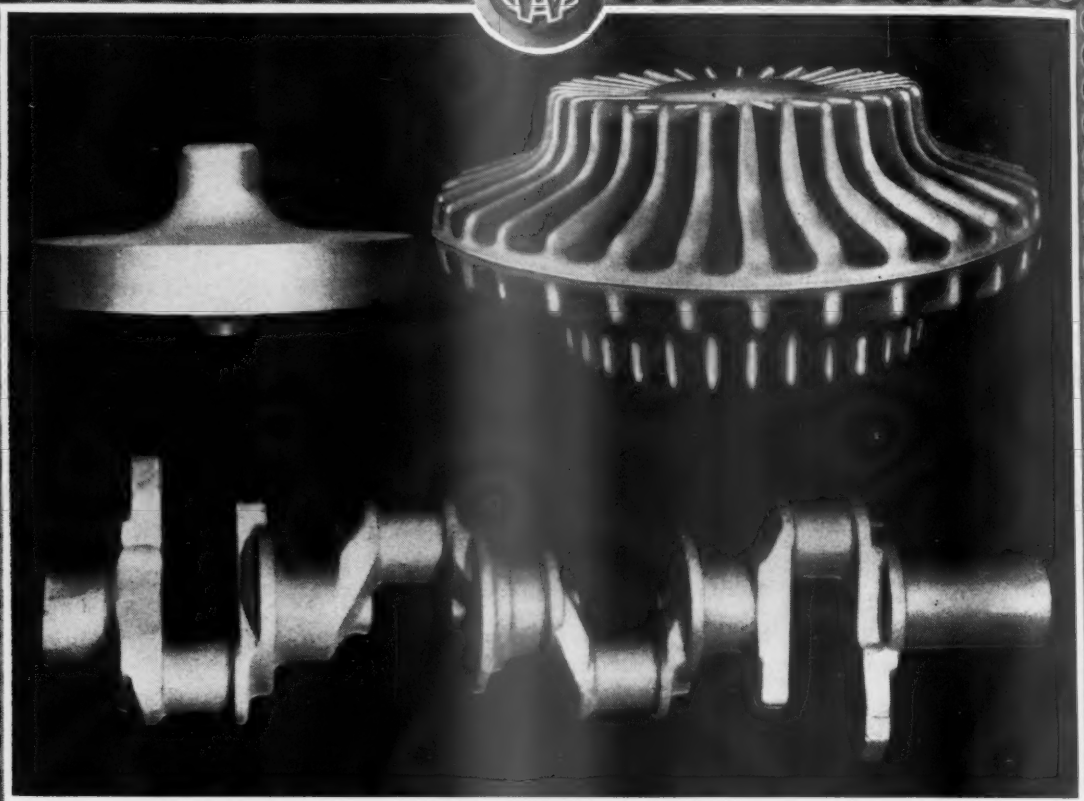
GOODYEAR
AVIATION
PRODUCTS

SIXTH PRODUCTION LINE SIKORSKY HELICOPTER

The new H-19 is shown here in use as a flying ambulance during the action at the Munsan perimeter north of Seoul, Korea (Photo U.S. Air Force—Wide World)



Wyman-Gordon — specialists in the vital forgings of the internal combustion engine since its inception — is today the largest producer of crankshafts for the automotive industry and of all types of forgings for the aircraft industry. Be it crankshafts and other vital forgings for the piston type engines or turbine wheels and impellers for turbo jets — there is no substitute for Wyman-Gordon experience.

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Cover—The F-89 Scorpion, built by Northrop Aircraft, Inc., shows off its recently revealed armament details, as it fires 5-in. high-velocity aerial rockets during an air-to-ground firing test. The F-89 carries six 20-mm. cannon, in addition to having provisions for 16 5-in. HVAR rockets (eight under each wing). This all-weather interceptor is powered by twin Allison J-35 turbojet engines equipped with afterburners.

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AERONAUTICAL ENGINEERING REVIEW

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Tape controls pull of 14,500 pound-seconds in JATO unit with Polyken Tape No. 276. Picture taken at the Aerojet Engineering Corp.

Tape holds 18 times the force of gravity

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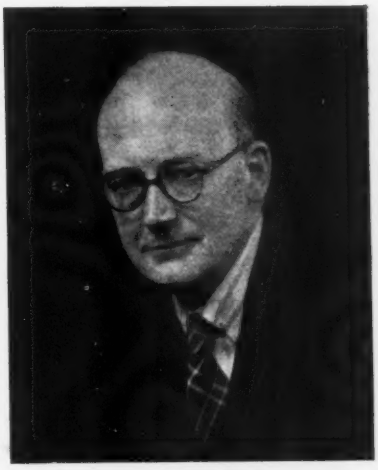
I. A. S. News

A Record of People and Events of Interest to Institute Members

British Scientist To Present Fifteenth Wright Brothers Lecture

Dr. P. B. Walker of Britain's Royal Aircraft Establishment Selected As Wright Brothers Lecturer



Dr. P. B. Walker, Wright Brothers Lecturer for 1951.

ON THE FORTY-EIGHTH ANNIVERSARY of man's first free, controlled, and sustained flight of a power-driven, heavier-than-air machine by Orville and Wilbur Wright at Kitty Hawk, N. C., the Fifteenth Wright Brothers Lecture will be delivered by the eminent British scientist, Percy Brookbank Walker, Ph.D., F.R.Ae.S., who for the last 6 years has been Head of the Structures Department, Royal Aircraft Establishment, Ministry of Supply, Farnborough, Hampshire (Hants), England.

The lecture will be initially presented on December 17 in the U.S. Chamber of Commerce Building Auditorium, Washington, D.C. It will be repeated in Cleveland and in Los Angeles on dates to be announced later. All members and guests of the Institute of the Aeronautical Sciences are cordially invited to attend.

▸ **The Lecturer**—Dr. Walker was graduated with a B.A. degree in Mechanical Sciences from Cambridge University in 1926. He was engaged in fluid motion research at Cambridge from 1926 to 1930 under Sir B. Melville Jones, for which he was granted his Ph.D. (Cantab.) in 1931. In 1930, upon concluding his research in fluid motion, he was employed as a designer on the staffs of Armstrong Whitworth Aircraft, Ltd., and Hawkers Aircraft, Ltd. He remained in the British aircraft industry for 5 years and then resigned to join the Airworthiness Department of the Royal Aircraft Establishment. Early in 1940, he became Assistant Director of Research and Development for Aircraft at the Ministry of Aircraft Production. (It was under this particular Ministry that the R.A.E. operated during World War II.) Dr. Walker's present duties, though broadly described as "structures," actually include vibration, flutter, fatigue, and airworthiness, as well as conventional research and development.

Dr. Walker has authored many papers that have appeared in the *Reports and Memoranda of the Aeronautical Research Council* (England), in *The Journal of the Royal Aeronautical Society*, and in certain other technical publications. These papers include: "Simple Formulae for the Fundamental Natural Frequencies of Cantilevers" (1937); "The Technique of Wing Resonance Tests" (with A. W. Clegg, 1939); "Rational Stressing Cases for Symmetric Flight" (1944); "Retardation Efficiency of Shock Absorber and Arrester Gear" (1945); "Mechanical Vibration and Aeroelasticity" (1947); "Stability of an Aircraft Structure in a Strength Test Frame" (1947); "Fatigue of Aircraft Structures" (1949); and "Destructive Energy in Aircraft Pressure Cabins" (1950).

▸ **The R.A.E.**—The Royal Aircraft Establishment, with which Dr. Walker is associated, is the principal research station in the United Kingdom. It is divided into at least 14 departments that include Aerodynamics, Radio, Structures, Armament, Instrumentation, Metallurgy Mathematical Services, Guided Weapons, and Experimental Flying.

Although the R.A.E. has occupied its present 55-acre site in Farnborough since 1905, its history antedates this by many years. In speaking of its beginnings, an official R.A.E. statement from the 1946 edition of *Industrial Research* tells us: ". . . In 1878 the War Office began experiments with balloons at Woolwich and later, Chatham; in 1890 the R.E. Balloon Section was formed at Aldershot; in 1894 a balloon factory (a very small affair) was established at Farnborough; in 1909 the work of the factory changed from balloons and man-lifting kites to airships and then to aeroplanes; in 1914 the production of planes and engines was started and the name changed to Royal Aircraft Factory; and in 1918, when the production of planes was taken over by aircraft firms, the name was again changed to Royal Aircraft Establishment to avoid confusion with the R.A.F. The work of the R.A.E. then became, and remained, purely experimental."

▸ **The Annual Lecture**—The Wright Brothers Lecture, an annual I.A.S. feature, is endowed by the Vernon Lynch Fund and was established in 1937.

1951 Guggenheim Medalist

Igor Ivan Sikorsky

. . . "for a lifetime of outstanding contributions to aeronautics, including pioneering with multi-engine airplanes, flying boats, amphibians and helicopters."

Igor Ivan Sikorsky has been selected as the winner of the Daniel Guggenheim Medal and certificate for 1951. Mr. Sikorsky was cited "for a lifetime of outstanding contributions to aeronautics, including pioneering with multiengine airplanes, flying boats, amphibians and helicopters." The award is to be presented during the 1951 National Aeronautical Meeting of the Society of Automotive Engineers which is being held in Los Angeles from October 3 to 6, inclusive.

Mr. Sikorsky was the unanimous choice of the 22-member board that is composed of the previous recipients of this medal who reside within the United States and the representatives of the American Society of Mechanical Engineers, Institute of the Aeronautical Sciences, and Society of Mechanical Engineers.

Mr. Sikorsky, who was born 62 years ago in Kiev, Russia, was graduated from the Naval College, St. Petersburg, in 1906, and from Kiev's Mechanical Engineering College of the Polytechnic Institute 2 years later. He has been granted honorary degrees from Yale University, Wesleyan University, Lehigh University, Florida Southern College, Rhode Island State College, Northeastern University, and the University of Pennsylvania.

Mr. Sikorsky first began to design and build flying machines in 1909 on his own account. Approximately 3 years later, he was employed in this field as Designer and Engineering Manager of the Russian Baltic Car (Railroad) Company's Aeronautical Department. In 1913, he was responsible for the design and construction of 75 large four-motored bombers for the Russian army. In 1918, he went to France, where he was commissioned to build Sikorsky planes for military use. The production of these ships, however, was halted by the signing of the Armistice, and the following year Mr. Sikorsky came to the United States.

This year's Guggenheim Award winner organized the Sikorsky Aeronautical Engineering Corporation in 1923. Through a series of organizational and corporate title changes, the present firm of Sikorsky Aircraft Division, United Aircraft Corporation, was formed under that name during World War II. Mr. Sikorsky is Engineering Manager of the present Sikorsky company.

The author of several published books and the recipient of many honors and awards from various organizations for his work in the aeronautical field, Mr. Sikorsky is an Honorary Fellow and Founder Member of the Institute. He is also a member of the American Society of Mechanical Engineers and the Society of Automotive Engineers.

Aeronautical Fellowships Awarded

Seven students have been awarded fellowships for graduate study in science and engineering at Cornell University by Cornell Aeronautical Laboratory, Inc.

One of the seven fellowships was given in the name of Cornell Aero Lab, itself. The remaining six were named for industrial firms that have contributed to the laboratory's support. These firms are Avco Manufacturing Corporation; Bell Aircraft Corporation; Curtiss-Wright Corporation; Fairchild Engine and Airplane Corporation; Grumman Aircraft Engineering Corporation; and Republic Aviation Corporation.

These fellowships, first established in 1949, are financed by the laboratory from fees earned on contract research. They provide $1,200 a year plus tuition and fees and are renewable. The laboratory's research facilities are open to the fellows during their study at Cornell University.

The winners of the seven fellowships are as follows: Avco Manufacturing Corporation fellowship in aeronautical engineering to Theodore R. Goodman, T.M.I.A.S., of Buffalo; Bell Aircraft Corporation fellowship in electrical engineering to David H. Blauvelt, of Paramus, N.J.; Curtiss-Wright Corporation fellowship in aeronautical engineering to Frederick R. Riddell, of Qualicum Beach, Vancouver Island, B.C., Canada; Fairchild Engine and Airplane Corporation fellowship in aeronautical engineering to Edward L. Rice, of Bronx, N.Y.; Grumman Aircraft Engineering Corporation fellowship in aeronautical engineering to William E. Smith, T.M.I.A.S., of Buffalo; Republic Aviation Corporation fellowship in electrical engineering to James Q. Brantley, Jr., of Tampa, Fla.; and Cornell Aeronautical Laboratory fellowship in physics to John E. Hove, Jr., T.M.I.A.S. of Buffalo.

Fluid Mechanics Conference Set

The Second Midwestern Conference on Fluid Mechanics is to be held at The Ohio State University, Columbus 10, Ohio, on March 17–19, inclusive, according to a joint announcement of the sponsors. The sponsoring organizations include: The Graduate School of The Ohio State University; American Meteorological Society; American So

ciety of Mechanical Engineers; Institute of the Aeronautical Sciences; American Physical Society, Fluid Dynamics Division; American Institute of Chemical Engineers, Columbus Section; American Society of Civil Engineers, Columbus Section; and other leading organizations interested in fluid mechanics.

The technical coverage of the Conference is intended to be broad. Authors, therefore, are invited to submit papers on any facet of theoretical or applied fluid mechanics. Papers dealing with new applications or new theoretical or experimental methods and/or results are especially welcomed.

In order to be considered for presentation at this Conference, either complete papers (which shall be no longer than 3,000 words) or abstracts must be forwarded by their authors to the Chairman of the Editorial Committee, Ralph Powell, Mechanics Department, Ohio State University, before December 1, 1951. As the Proceedings of the Conference are scheduled to be published, the final date for submitting complete manuscripts is February 1.

Inquiries should be addressed to the Secretary of the Conference, Goeffrey Keller, Department of Physics and Astronomy, Ohio State University.

University of Wichita Honors Memory of Walter H. Beech

The Walter H. Beech Memorial Windtunnel at the University of Wichita was formally dedicated on July 15.

During the dedication ceremony, Harry F. Corbin, President of the University, and Dwane L. Wallace, President of Cessna Aircraft Company, paid tribute to the late Walter Beech, I.A.S. Founder Member and Member, who at the time of his death on November 29, 1950, was President and Chairman of the Board of Beech Aircraft Corporation, which he had founded in the early 1930's.

A bronze plaque, mounted at the entrance of the wind-tunnel administration building, was unveiled by Mr. Corbin. The plaque bears the inscription: "Walter H. Beech Memorial Windtunnel. Dedicated this 15th day of July, 1951, to the memory of Walter H. Beech, 1891–1950, an aviation pioneer whose faith in the aeronautical future of America will be confirmed through continued education and research."

This 7- by 10-ft. wind tunnel began operating in 1948 and is used for aeronautical research by the University's School of Engineering, local aircraft companies, and the Armed Forces. Among the original contributors to the wind-tunnel fund in 1945 were Beech Aircraft Corporation, Cessna Aircraft Company, and the Kansas State Industrial Development Commission.

Necrology

Dr. B. A. Bakhmeteff

Dr. Boris Alexander Bakhmeteff, A.F.I.A.S., died of a heart attack on July 21 at his home in Brookfield, Conn. He was 71 years old.

Born in Tiflis in the Russian Caucasus, Dr. Bakhmeteff was graduated from the Classical Gymnasium, Tiflis, in 1898 and 5 years later was awarded a degree in civil engineering from the Institute of Engineers of Ways of Communication, St. Petersburg. In 1911 at St. Petersburg, the Polytechnical Institute of Emperor Peter the Great conferred upon him the degree of Adjunct Applied Mechanics, which corresponds to the Doctor of Engineering degree.

Dr. Bakhmeteff first came to the United States in 1904 to partake in the work on the New York State Barge Canal. Returning to his native land the following year to accept a professorial position with the Polytechnical Institute, St. Petersburg, he was sent back to this country in 1915 as Chief Plenipotentiary of the Russian Government's Central War Industries Purchasing Committee.

After the fall of the Czarist regime in 1917, Dr. Bakhmeteff was appointed Vice-Minister for Commerce and Industry of the Provisional Government headed by Prince Lvov. Later that same year, the Menshevik government under Alexander Kerensky sent him to the United States as Russian Ambassador. Kerensky's Menshevik government fell a short time later, but Dr. Bakhmeteff remained in this country. In June, 1922, he declared himself to be an ambassador without a country and resigned.

Re-establishing his earlier profession, Dr. Bakhmeteff became Consulting Engineer in New York, and, some years later, in 1931, he was appointed to the faculty of the Columbia University School of Engineering. Recently, Columbia University elevated him to the position of Honorary Professor, thus making him the fourth person in the University's history to acquire that title.

Dr. Bakhmeteff, who had been an American citizen since 1935, was the Founder and President of the Lion Match Company. He was an Honorary Member of the American Society of Civil Engineers and a member of the American Society of Mechanical Engineers and the New York Academy of Sciences.

Dr. Bakhmeteff is survived by his widow, the former Maria Helander Cole, by his sister, Mrs. Julia Bazaboff, of New York, and by a stepdaughter, Carol Herrera.

Ensign Francis J. Gulshen

Ensign Francis J. Gulshen, U.S.N.R., T.M.I.A.S., was fatally injured in the crash of his training plane on May 22 The accident occurred while he was practicing simulated carrier landings at Barin Field, near Foley, Ala. On one of the landings, he lost control of the ship at an altitude of about 250 ft. and crashed. He died a few hours later.

Ensign Gulshen, who was awarded his commission posthumously, was born 26 years ago in Kewanee, Ill., and attended the local high school. Matriculating at the State University of Iowa in 1946, he was graduated from there in 1949 with a B.S. degree in Mechanical Engineering with an Aeronautical Option. He began his flight training as a Naval Cadet in September, 1949, at the Pensacola Naval Air Station, Fla.

He is survived by his parents, Mr. and Mrs. Frank E. Gulshen.

Charles T. Holbrook

Charles Tyler Holbrook, T.M.I.A.S., died suddenly on June 18 near his home in East Haven, Conn. He was 28 years old.

A native of New Haven, Conn., Mr. Holbrook attended the East Haven (Conn.) High School and began his undergraduate studies at the University of Alabama in 1942. He interrupted his studies for a 3-year period, while he served with the Army of the United States during World War II. In 1946, he resumed his work at the University of Alabama and was graduated from there 2 years later with a B.S. degree in Aeronautical Engineering.

(*Continued on page 36*)

Automobile tops, insulated with L·O·F Fiber·Glass against heat and cold, increase passenger comfort. Easy installation. Light weight. Won't deteriorate under normal conditions.

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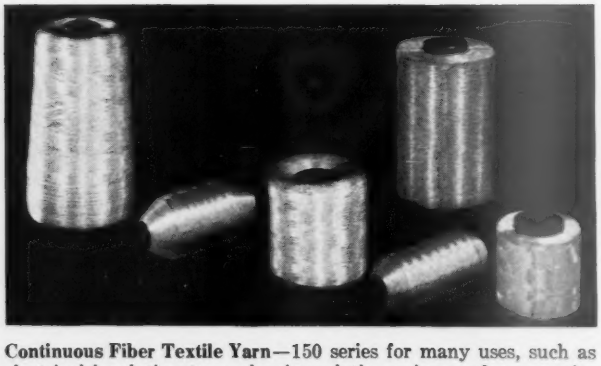
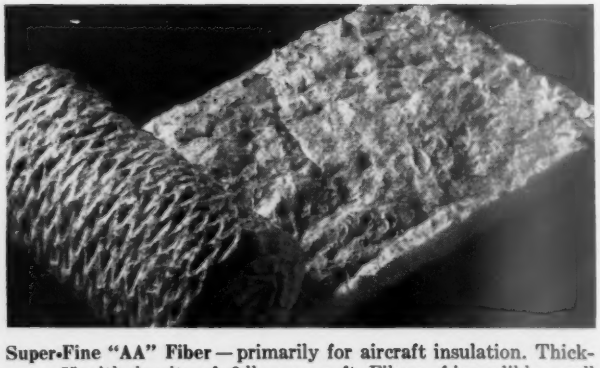
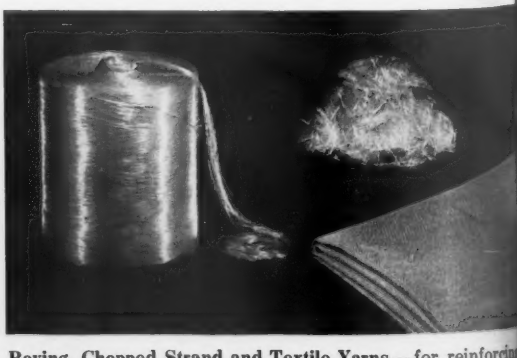


Continuous Fiber Textile Yarn—150 series for many uses, such as electrical insulating tape, sleeving, cloth, roving, and paper reinforcement. Glass fibers have enormous tensile strength . . . 1½ million pounds per square inch and higher. High dielectric strength. Withstands temperatures up to 800°F.

Super-Fine "B" Fiber—Splendid thermal- and sound-insulating qualities. Fiber diameter, .00012". Temperature range -0°F. to plus 450°F. Standard roll widths, 18", 24", 36", 72", in 100' and 200' lengths. Other widths and lengths also available in a range of thicknesses and densities.



Super-Fine "AA" Fiber—primarily for aircraft insulation. Thickness, .5" with density of .6 lb. per cu. ft. Fibers of incredibly small diameter—.00004". With plastic binder to hold dimensional form. Roll widths, 36", 72", in 50' standard length.



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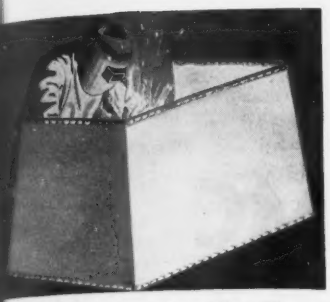
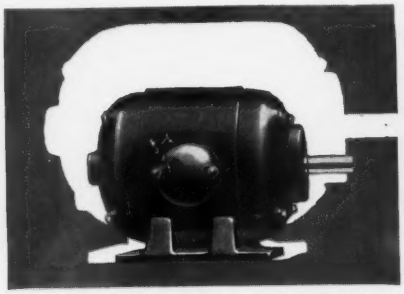
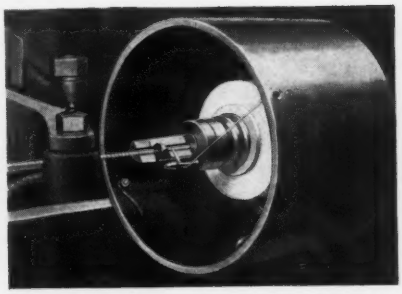


Industrial fabrics woven from Fiber·Glass are fine, safe, strong, rot- and mildew-proof. Ideal applications are tarpaulins, flame shields, airplane cloth, reinforcement for plastics.



Electric motors and generators insulated with L·O·F Fiber·Glass withstand heavy overloads. Appreciable space factor advantages! High dielectric strength.



Wire and cable can be served directly with L·O·F Fiber·Glass textile yarns using standard machines. Yarn also ideal for weaving tape, and braiding on wire and into sleeving.

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Across the country, in 24 major cities, L·O·F offices are busy with preparations to give you help on specific uses.

If your company has already discovered the superior qualities of fibrous glass, investigate L·O·F now as a new volume source, worthy of your complete confidence.

If your company now buys other material for electrical insulation, thermal or acoustical insulation, or reinforcing for plastics or paper, L·O·F Fiber·Glass can offer a combination of advantages unmatched by such other materials. This is a chance to benefit from the glass technology and the high standard of quality which you have come to expect from L·O·F!

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Plastic reinforcing, as in this bread tote tray, presents many possibilities with L·O·F Fiber·Glass. Remarkable strength. Won't dent or lose shape. No discoloration of plastic material. Exceptionally long life.

Paper and paper tape reinforced with L·O·F Fiber·Glass can be raised in tensile strength to equal aluminum or even steel! Either Fiber·Glass textile yarns or scrim mesh are suitable. Investigate!

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AMC

*The Biggest Business in the World**

by

LT. GEN. B. W. CHIDLAW
Commanding General
Air Materiel Command

General Chidlaw, principal speaker at the Institute's Annual Summer Meeting Dinner, delivered the following address before approximately 500 I.A.S. members and guests in the Embassy Room of the Ambassador Hotel, Los Angeles, June 28.

Other highlights of the Dinner included the customary presentation of the Thurman H. Bane and Octave Chanute Awards to J. B. Johnson and Lt. Col. Marion E. Carl. Details of the awards were published in the August REVIEW.

* An address delivered June 28, 1951, at the Institute's Annual Summer Meeting Dinner, Ambassador Hotel, Los Angeles, Calif. This article appears in place of the usual editorial.

"WHY DOES THE AIR MATERIEL COMMAND currently enjoy the reputation as the world's biggest business? Simply because we are the logistics arm of the Air Force and, as such, are charged with the procurement, production, inspection, supply, and maintenance of Air Force equipment on a world-wide basis. Is this responsibility something new? No, not exactly!

AMC Missions

"It might be said that our basic mission goes back to the first Continental Congress, when, on the 4th of July, 1776, after signing the Declaration of Independence, the Congress then passed a resolution to give the so-called 'Board of War' power to hire people, 'to manufacture flints for the Continent, and to discover places where the best flintstones are to be obtained.' Needless to say, the military logistics mission has broadened considerably since that time.

"Today our mission supports not only the military strategy of the nation but also our nation's foreign policy. For instance, as you know, we are currently hard at work to supply and support a 95 Wing Air Force. At the same time, we are reconditioning stored World War II equipment and buying new equipment so that the United States can assist approximately 30 other nations of the world under the Mutual Defense Assistance Program. This year the Air Materiel Command is administering over $1,500,000,000 on this project alone—the equipment is not for procurement and use sometime in the remote future, but for today. Just as soon as we can get it! And this program has an equal priority with our own 95 Wing Program.

"In addition to the part of this program that the United States is financing, we are also buying equipment for Canada and a few other nations who are financing their own programs. Not only do we have the responsibility of buying that which is necessary to fill today's known requirements, but we must also be planning for the needs of, say, 5 or 10 years hence. Whether these needs will then be larger or smaller, this part of the job requires a mighty clear crystal ball when we consider all the factors that enter into it.

"Fundamentally, the basic mission of the Air Materiel Command resolves itself into converting our allotted portion of the yearly national budget into Air Force materiel and logistical support and to the planning of future expenditures so as to 'buy the most with the least.'

"A secondary, but no less real, phase of this job is convincing the Air Staff, the Secretary for Air, the

Secretary of Defense, the Bureau of the Budget, the Congress, and the people that our allotted portion of the national economy must be enough to fulfill our mission.

Time Limitation

"In doing the actual work required, we must overcome many limitations. Most of these limitations we can meet and overcome, but one almost insurmountable limitation is that of time. I know that I need not convince you that it takes many months to *plan*, to *develop*, and then to *produce* the various items of equipment which we need. But surprisingly enough, a great segment of our nation's people just cannot understand that we are unable to buy back 'time' with dollars. We are expected always to have produced *tomorrow's* equipment *yesterday*. This problem of 'lead time' becomes increasingly serious, even more so than during those hectic and frantic early days of World War II. During the last war, the air frame itself was frequently the long lead-time item. Now our equipment is becoming so complex, with tolerances so small and with so many manufacturers and subcontractors involved, that many component items are far more critical than the air frame insofar as lead time is concerned.

"Our complicated electronics equipment is a good example of this, and, with this question of lead time so involved, it means that we must frequently start production of this particular equipment before we actually know how the airplane or the vehicle into which this equipment will go will actually look or perform.

"Another facet of this lead time is becoming increasingly obvious now that we are involved in a major expansion. I refer to machine tools. This is one of our major problems today. For instance, we read in the papers about the 75,000-ton press, from which the general public might infer that we can produce great sections of an air frame in a single operation. Of course, we will some sunny day after we get going on this. But if we try to buy *right now* a relatively simple machine tool, we are apt to find that we have to wait from 22 to 36 months for delivery.

Influence of Nation's Economy

"Another direct and major influence on our ability to accomplish our mission is the economic state of the nation. It affects us, and, certainly, we affect it. Our military programs must always be geared in delicate balance with the civilian economy.

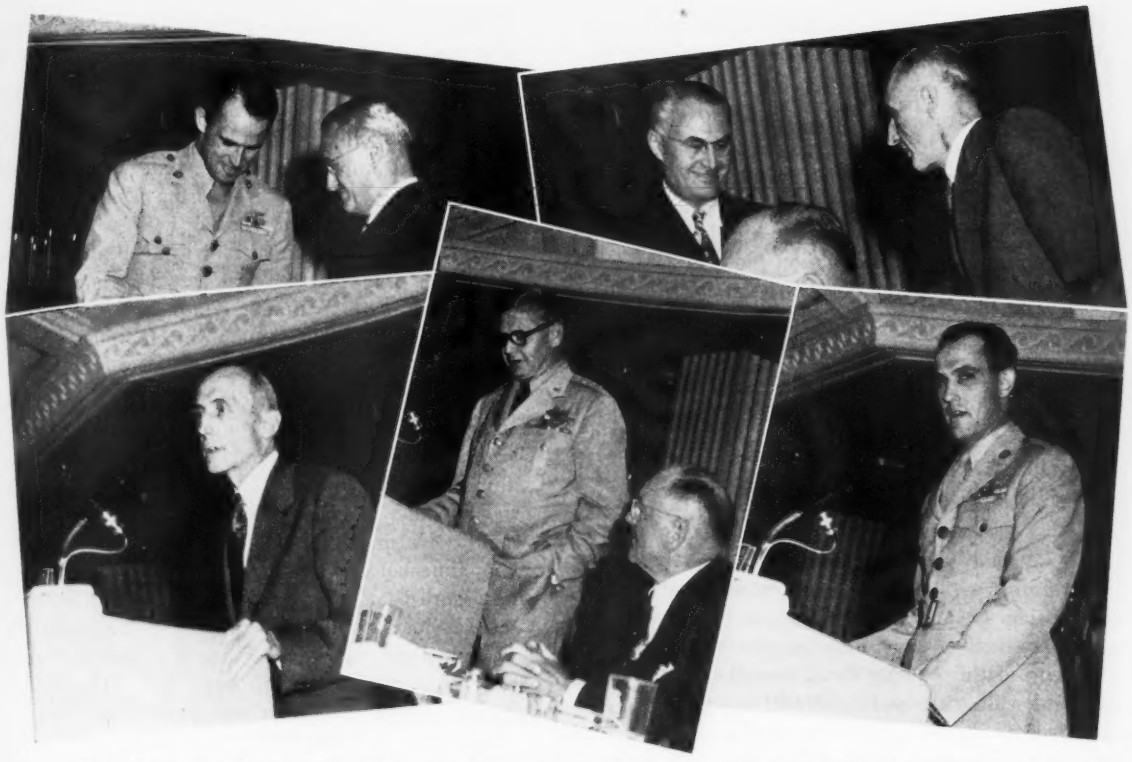
"I might digress for a moment and give you a concrete example of how the economic state of the country affects the delivery of our equipment. One of our jobs at the Air Materiel Command is to ensure the procurement of the proper uniforms for the Air Force. A year or so ago, the plans for the Air Force blue uniform, its procurement, its storage and issue were set into operation. Our plans, made well in advance, had *at that time* a 'built-in' margin of safety—that is, for a 48 Group Air Force. The economy then was in a fairly comfortable state, man power was adequate, labor conditions in the textile industry were reasonably quiet, and prices, though high, were comparatively stable; the basic commodity, wool, as projected against our demands, was in adequate supply. Proper funds had been budgeted for and allocated against this program. But a few short months passed by and the Air Force program then called for 95 Groups. Those months have made a tremendous difference. Our economy is considerably tighter, man power had moved into short supply, labor troubles hit the textile mills, and, inevitably, price increases hit the wool market. What would have been completely adequate for a 48 Group Air Force would not stretch to cover the expanding Air Force program. These factors compounded into this end result—many of our recruits just did not have, upon reporting, the kind or type of equipment we all desired to see them have, and we had to resort to many substitutions and improvisations to tide us over that period. We are just now coming out of the woods and starting to see daylight on this one. And remember that uniforms—clothing—is only one item out of tens of thousands that the nation's economical state affects.

Problems in Buying Uniforms

"While on this subject of uniforms, it might be interesting to show you just a few of the problems involved. It isn't too difficult for anyone to go downtown and buy himself a new suit of clothes. While I admit prices are a bit higher than we would all like to pay, nevertheless, you are reasonably sure of getting something that looks well, fits well, and wears well. Why should the problem then of buying a million suits of clothes be particularly difficult? Do you just write out a purchase order for one uniform and then put a few more ciphers behind it, get the Comptroller to check off the funds, and call it a day? Far from it!

"In the first place, the American lad of today, size-wise and weight-wise, is not the lad he was only 6 or 8 short years ago during World War II. We know that the tariff of sizes of World War II was a long way from being that of the average of World War I. As a nation we are growing bigger, not only in numbers but also in the size of the individual. If you don't believe that, just watch a group of late teen-age youngsters walking down the street with their Mothers and Dads, and see who is the larger.

"Suppose you are buying clothes for one million individuals. We find that we must maintain in our clothing stores and on our shelves a rather appalling number of different sizes of each and every piece of equipment we buy. For example—shoes. You might not believe this, but I can assure you that we have to stock 239 different sizes and types of shoes. Don't forget, in today's Air Force we are outfitting both men and women. One hundred and twenty-nine different sizes and types of coats sound fabulous, and yet they range all the way from a 32 extra short to a 50 extra long. Most of you buying a new hat would imagine that anything between a $6\frac{1}{2}$ to a $7\frac{3}{4}$ ought



(Top left), Lt. Col. Marion E. Carl receives the Octave Chanute Award from Adm. L. B. Richardson, I.A.S. President. *(Top right),* Admiral Richardson presents the Thurman H. Bane Award to J. B. Johnson. *(Bottom, left to right),* Mr. Johnson, General Chidlaw, and Lt. Colonel Carl as they addressed the audience at the Summer Meeting Dinner.

to cover the water front. It doesn't. We have to stock some 13 different sizes and types of caps.

"Quite naturally, the largest amount of our procurement of these and similar personal equipment items falls into the more normal range of sizes, and yet we must have on our shelves sufficient quantities of the out-sizes to permit rapid equipment of the new airmen as they enter the Service. I guess if we had our 'druthers,' we would like to see all the airmen of one size and type but, unfortunately, Mother Nature doesn't work that way. The permutations and combinations of scores of these uniform items (and I have mentioned only two or three) can be alarming.

Big Business

"The proper discharge of our responsibilities for planning, buying, and maintaining the complex Air Force equipment requires an organization capable of performing the functions of just about any civilian business in the world. That means in reality that the Air Materiel Command is 'big business.' In fact, the biggest single business in the world today. At present, we employ 135,000 civilians plus 22,000 military personnel. We are pretty big bankers on payday, because our annual pay roll approximates $600,000,000.

"Including supplementary budgets, the Air Materiel Command is presently buying at the rate of approximately $10,000,000,000 a year. In fact, in a recent month, we let over 2,400 contracts, totaling well over $1,000,000,000. That was just one month's work in our Procurement Division, and it is inevitable that this will increase.

"In this clamor for military equipment, we are faced with a problem of like concern to all of us. Regardless of how badly we need this equipment, we must not buy in such a fashion that it might create the straw that would break the nation's economic back in any one of the commodity fields. This we must always keep before us, but I can assure you it is mighty difficult to fight a 'hot' military logistics war under a national 'cold war' frame of mind.

Equitable Distribution of Business

"There is one aspect of our Procurement activities of which I am quite proud—the way we are going about spreading our business. We have about 3,000 prime contractors who, in turn, have over 60,000 subcontractors. Thus, our huge Procurement program has been designed to: (1) spread the military dollar across a wider segment of industry; (2) make maximum use of available industrial capacity; and (3) permit manufacturers to continue operation despite cut-backs in strategic materials for nondefense purposes.

"You may have read recently where the Services have been severely criticized for favoring big business. Certainly, conditions of urgency frequently demand a larger percentage of negotiated contracts than we would like to see, but I feel that such criticism is not fully

justified in light of world conditions and the necessity of really getting into high gear with our Procurement program.

"Moreover, let me point out that we have long recognized the fact that small enterprise is the 'backbone' of American business. We know that this is especially true today. Our 'Operations—Small Business' program is serving an additional purpose of bringing more manufacturers into the production picture. We have even gone so far as to conduct a series of small-business clinics across the country where leaders of large and small enterprises can meet on a common ground and iron out their production problems. Despite all of the controversy, I think you will find it significant to note that the Air Force has issued figures to prove that almost 75 per cent of contracts will go to small business subcontracting for Air Force prime contracts.

Stock and Storage

"Naturally, with all those contractors and all this money being spent, production starts to roll and the equipment starts to come into our inventory. In fact, by the end of this coming fiscal year the Air Materiel Command will stock over 1,000,000 separate items or classes of equipment. By comparison, Sears and Roebuck, one of the largest civilian distribution businesses, runs a poor second with something less than 200,000 items. This gives you a pretty good idea of what we are up against in the distribution field.

"Now, again with these 1,000,000 items rolling in off the production lines the problems of packaging, storage, issue, recovery, and repair come to the front. To store properly this ever-changing inventory is no small matter. In fact, the Air Materiel Command controls about 18,000,000 sq. ft. of covered warehouse space—about room enough for 300 football games to be played at once—and, frankly, this is far from enough. We are building, renting, or leasing space wherever we can in order to minimize the open storage of our complex and expensive equipment items.

Other Projects

"To keep the Air Force Supply and Maintenance system always up to date, we publish about 12,000 separate technical publications every year, sometimes running into the tens of thousands of thousands of copies of a particular publication.

"You may recall that back in 1945 at the end of World War II we initiated a machine tool storage project. We rounded up, cataloged, and stored about 49,000 of the most modern of our machine tools, valued today at something over $1,000,000,000. Now that we are in the process of expansion, we have already furnished to the industry over 21,000 of these machine tools, with thousands going out every month. The cost of that storage is being repaid many times over, not only in money but in that ever more precious commodity—*time*.

"Being in a period of expansion *now* does not mean that we are planning for *only* expansion ahead. We must always have in mind the eventual demobilization ahead of us at some point and be looking to the day our requirements will be less and less. You might be interested to know that all the time we were working so hard—day and night, around the clock—to effect the build-up for Korea and the Far East, we had another group working with equal zeal to keep always current our plans for the recovery, repackaging, shipment, and return of this valuable equipment to the ZI or to other theaters. This demobilization must always be an element of our planning.

"Another phase of our planning which is extremely complicated is that of computing requirements for ground-handling equipment, spares, and other items auxiliary to the aircraft before we have had the time to run sufficient tests on the airplane itself or its equipment. Naturally, like so many people who waited a long time before buying a television set because they were sure that colored television or a better, cheaper set was just around the corner, we too would like to wait until we could have a plane or a piece of equipment go into production with no 'bugs' in it. On that happy day we could then plan our ground-handling equipment, our spares, and so forth in just the *right* configuration and in *exactly* the number needed. Wouldn't that be fine for the taxpayers? Sure it would! But if we were to follow that practice in face of this rapidly moving, ever-changing airplane business of today, we would soon find ourselves lagging behind the enemy's frenzied developments and end up with an inferior, second-best Air Force. Remember that we're not calling the signals yet in this bigger war we're in—Joe and his boys are doing that, and we must be ready to meet him with the very best we have at any time.

"Certainly this practice of putting articles into production before they are fully tested and proved leads to many headaches for ourselves, for the industry, and for the combat people who find themselves up to their ears in development and service test problems when they have other jobs to do. It is an expensive way of doing things and we deplore the necessity of having to do it this way. If we knew of an easier, cheaper, better way of doing the job we would certainly adopt it.

Supply and Priority

"Another costly, but still necessary, requirement is that of having complete equipment, both operational and personal, for any section of the world, under any circumstances. We must be prepared to move overnight from one extreme to another. We must have a complete stock of summer uniforms in winter, winter uniforms in summer, winterization kits for airplanes and vehicles now operating in the tropics. The packaging aspects of our supply and transportation problems are little short of terrific.

"Another incongruity of our supply system is that although we would like to send to Korea every single

item the fighting man feels that he may need, nevertheless, we have to keep them in the 'lean and hungry' status, because in these uncertain times we never know at what moment we may be required to throw our major effort—our Sunday punch—in another direction. Just enough but not too much has to be our philosophy, dislike it as we may.

"Speaking of denying certain items to the Korean theater brings us to the subject of priorities—a major Air Materiel Command headache. As you know, many priorities have been established, yet everyone comes to us with what is, to him, a No. 1 priority. In the Far East, General Stratemeyer's successor, General Weyland, is waging a shooting war. Surely, when men are dying, *in battle,* the priority is high. Name one higher! Yet consider General Whitehead and his Air Defense Command. They have the terrific responsibility of defending all approaches to the continental United States. What happens if half a dozen Russian bombers get through with A-bombs to six of our cities? Certainly, the Air Defense Mission ranks high in priority. Yet General LeMay, who is not now fighting but is carrying our big stick, certainly has the highest priority with his Strategic Air Command. To each individual commander, his needs are rightly first priority, but, to us in the middle, everyone can't be first.

Korean Combat True Proving Ground

"If the old journalistic axiom is true, and a picture is worth a thousand words, then, from our viewpoint, the proving ground of actual combat may be worth a thousand state-side equipment tests. It is in heated conflict that the machines we have produced are put to the use for which they are intended. If the armor plate deflects the bullet; if the self-sealing gas tank seals when hit; if our bombers can reach their targets, leave their trademark, and return; if the thousand and one component parts and pieces of equipment do the job for which they were designed; it is then, and only then, that we know the true measure of our success.

"Because we prefer to use first-hand information to check on the performance of our aircraft, I recently traveled over 22,000 miles covering the Korean operation and those Pacific bases supporting it. In the course of my travels, I was confronted with a lot of problems, which to varying degrees, are Air Materiel Command's to solve. For example, I talked with fighter pilots about their personal flying equipment. On this subject, these fighting men had some very definite ideas, and most of them were different. However, there was one general idea that stuck in my mind after all opinions had been expressed. The consensus was that equipment should be more compact to permit unrestricted movement in the small cockpit of the fighter plane. But these flyers still wanted enough equipment to see them safely through on the 'walk back home' in the event they were shot down behind enemy lines.

"Those 'very definite' requirements voiced by our pilots at the front led to progressive refinements and developments in making our equipment more compact. For example, one of these items is a survival kit that actually forms the seat of the parachute. It contains a stove and sterno cubes, a medical kit, a water-purifying kit, atabrine, sulpha, rations, fish hooks, and even a combination shotgun and .22 caliber rifle. Needless to say, this kit is pleasing our fighter pilots.

"Actual combat brings out a horde of problems in varying degrees of importance. But they must be solved. For instance, our new bright, blue uniforms take on a dark brown or black hue in Korea after the typhus disinfectant crew has finished its duties. Another more serious problem is with our JATO units. Strangely enough, we must reverse the old adage of 'where there's smoke, there's fire,' if we were to solve this one. Because the smoke from JATO obscures the runways for mass take-offs, we are trying to fire JATO without smoke.

"The use of modern, more advanced equipment causes many new problems to arise. For instance, we used pierced steel planking for bomber and fighter airfields all over Europe during the last war. Yet in Korea we found that PSP runways are too rough for our jet planes. As take-off speeds increase with our more advanced planes, the degree of smoothness of the runway surface actually becomes as important a factor as its length.

"It was in Japan that I came across a completely different type problem. In one area we have a warehouse with a capacity of 800,000 sq. ft., which is adequate to accomplish the storage job at hand. And yet, by necessity, we must disperse these supplies (a lot of them outside in the weather) and, by so doing, create a far less efficient operation. With a potential enemy so near, we simply can't afford to have all of our supply eggs in a single basket.

Opportunity for Better Understanding

"By explaining some of the little known but important phases of Air Materiel Command's operations, I personally feel that we will have a better understanding of the important job at hand. Although the occasions are too rare, indeed, these days when I do have the opportunity to visit one of your places of business, I inevitably leave with the feeling that in some ways my own job can be accomplished more effectively. That brings to me a thought which I consider most important. When we are able to establish a closer personal relationship and have a better understanding of the other fellow's job, we find ourselves in a position to produce real, honest American teamwork—the kind of teamwork that produces victories. This team of ours must stand ready to out-think, out-produce, and out-fight any combination of foes that band together to threaten the free peoples of the world. I believe we can do it!"

Technical Sessions Annual Summer Meeting

Los Angeles—June 27–28, 1951

by

*Harold Luskin**

THE 1951 ANNUAL SUMMER MEETING of the Institute of the Aeronautical Sciences took place at I.A.S. Western Headquarters on June 27 and 28. The two morning, two afternoon, and one evening sessions included 18 papers whose subject matter was concerned with engineering design problems of aircraft and missiles. Registration totaled approximately 600. Unfortunately, military security prevented the scheduling of a field trip, which is usually a feature of the Summer Meeting.

The sessions were opened by **F. A. Cleveland,** chairman of the Los Angeles Section of the I.A.S. **S. Paul Johnston,** Director of the Institute, then made some introductory remarks, in which he pointed out the vital place of the I.A.S. in the national defense effort.

Aerodynamics

The technical sessions began in the morning of June 27. **Arnold Kuethe,** Acting Chairman, Department of Aeronautical Engineering, University of Michigan, was the session chairman. Mr. Kuethe was introduced by **F. A. Cleveland.** The papers of this session described recent work in three-dimensional boundary layers, boundary-layer–shock-wave interaction on cylindrical bodies, laminar-turbulent boundary-layer transition, and transonic gas dynamics.

The first paper of the morning session, "The Three-Dimensional Boundary Layer," was presented by **Wallace D. Hayes,** Consultant, Naval Ordnance Test Station, and Associate Professor, Brown University. Mr. Hayes successfully gave a nonmathematical description of the analytical procedure followed in his *Naval Ordnance Test Station Technical Memorandum No. RRB-105.* In that publication, the author derived the general equations for the three-dimensional laminar boundary layer on an arbitrary surface and specialized them for the particular cases of the flow about bodies of revolution, cylindrical flow, conical flow, and flow with small transverse accelerations. The three-dimensional analogs of the von Kármán integral relation were also derived. Mr. Hayes points out that, for the general case, the new phenomenon of cross flow appears, and, if the cross flow is weak, the equations governing it may be linearized. However, there is a general tendency for the cross flow to become greatly accentuated in the separation region, therefore precluding the application of a linearized theory there. The Busemann concept of cylindrical flow, with some modifications, may be used with viscous boundary conditions. Calculations show that, at high values of the axial Mach Number, the transverse boundary layer does depend to some extent on the axial solution. The case of steady-state conical flow is also treated, and, here again, the transverse boundary layer is never wholly independent of the radial boundary layer.

The results of an experimental investigation of shock reflection from a curved surface were presented in the paper, "Experiments on Interaction of Shock Waves and Cylindrical Bodies at Supersonic Speeds," by **M. V. Morkovin,** Associate Professor, **E. Migotsky,** and **H. E. Bailey,** all of the University of Michigan. The paper was given by Mr. Morkovin. Slides were shown which illustrated the phenomena of shock reflection from a three-dimensional body. In presenting the paper, Mr. Morkovin pointed out the striking boundary-layer cross flow induced by the sharp pressure gradient across the reflection "line" on the body surface. It was indicated that the cross flow in and outside the boundary layer results in a separated region on the lee side of the body. The effects of boundary-layer character and thickness and of shock strength on the overall flow and pressure fields were studied by means of body pressure distributions and several visualization techniques.

A new approach to the study of transition from laminar to turbulent flow was presented by **Howard W. Emmons,** Professor, Harvard University, in his paper, "The Laminar-Turbulent Transition in a

* Aerodynamics Research Engineer, Douglas Aircraft Company, Inc.

Bounday Layer."* A theory of transition was developed from observations on turbulence phenomena in a water surface. An interesting motion picture that indicated by use of lighting effects the development of "turbs" and the eventual transition to turbulence was shown. The author indicated that the flow at every point of a body is turbulent a fraction of the time, and a formula was derived for this fraction in a phenomenological manner. Application of the theory to available flat plate data gives some insight into observed effects and points the way to additional experimental results required.

The morning session was concluded with a paper by **E. V. Laitone,** Associate Professor, University of California, on "A Study of Transonic Gas Dynamics by the Hydraulic Analogy." The theory governing the propagation of surface water waves was reviewed to show that an analogy with two-dimensional gas flow exists only if the water depth is approximately 0.25 in., the model is large, and the shock waves or hydraulic jumps present are of the weak type. Photographs of water surface waves corresponding to shock waves in front of wedges and cylinders were presented to illustrate these restrictions. Mr. Laitone pointed out that the surface wave group velocity, which can be considerably less than the wave velocity, provides the only correct analogy to the speed of sound in two-dimensional gas flow. Motion pictures were shown which illustrated the effect of constant acceleration on the bow shock ahead of a body that is moving through a perfect gas that has a specific heat ratio of 2. It was found that the distance of a detached shock wave ahead of the body is dependent upon the acceleration parameter and not on the instantaneous Mach Number in the transonic regime.

Stability and Control

Russell Robinson, Assistant Director of Research, Ames Aeronautical Laboratory, National Advisory Committee for Aeronautics, chairmanned the June 27 afternoon session, which covered several subjects in stability and control. The effects on dynamic response of nonlinear aerodynamic characteristics, the analysis of automatic control systems, flight through a gusty atmosphere, and the problems of fuel sloshing and buffeting were discussed. **R. R. Heppe,** vice-chairman of the program committee, introduced Mr. Robinson.

The first paper of the session, "The Effects of Nonlinear Aerodynamic Characteristics on the Dynamic Response to a Sudden Change in Angle of Attack," was given by **Telford W. Oswald,** Research Engineer, Douglas Aircraft Company, Inc., Santa Monica Plant. This paper approaches the problem of the dynamic response to a sudden angle of attack change of a vehicle having nonlinear restoring and damping forces. An approximate solution to the nonlinear equation of motion was described. Several specific cases were studied, and results of the approximate method were compared with those from an accurate numerical solution and from the linearized solution. The approximate method was found to be generally satisfactory. The problem of the determination of stability derivatives from flight-test data, obtained on a vehicle with nonlinear aerodynamic properties, was also taken up.

Some of the problems associated with the increasing mechanization of flight were considered by **J. B. Rea,** President of the James B. Rea Company, Inc., in a paper entitled "Analysis of Systems for Automatic Control of Aircraft." Mr. Rea reviewed the recent rapid advances in aircraft automatic control, described the goals of an analysis of an automatically controlled aircraft, and described the elements of the system. "Pyramiding" as a way of dealing with these systems was described in detail, beginning with the vehicles' body modes, aeroelastic effects, nonstationary aerodynamics, guidance, servos, the target (for a weapon) and other elements, and ending with a complete system. Methods for analyzing the systems were discussed, and a plea for more and better machine computors of several types was made. More detailed studies of nonlinear problems and the development of methods for designing optimum aircraft within the system requirements were two parts of the problem needing considerable effort, according to Mr. Rea.

The problem of flight through a gusty atmosphere was taken up by **U. O. Lappi** in a paper entitled "An Investigation of Airplane Accelerations Due to Large-Scale Air Turbulence, and of the Power Spectral Density of the Turbulence." The paper was coauthored by **W. N. Turner** and presents methods used in a study being conducted at the Cornell Aeronautical Laboratory. The goals of the study are (1) to obtain statistical information on the response of an airplane to large-scale turbulence and (2) to obtain information on the gust structure. It is assumed that the disturbances are random, in the sense that complete time histories would be unpredictable. The quantities that are significant and which were determined from flight tests are the autocorrelations and power spectral densities. Calculations, based on wind-tunnel tests and using the transfer functions of the airplane, were made to correct the observed time histories for control-surface deflections. Finally, a method was developed for determining the gust structure from the time history of airplane response.

A discussion of two aircraft dynamics problems was given in a paper whose title was "An Analytical Approach to the Fuel Sloshing and Buffeting Problems of Aircraft." The authors, from the Douglas Aircraft Company, Inc., Santa Monica Plant, were **Harold Luskin,** Aerodynamics Research Engineer, and **Ellis Lapin,** Design Specialist. Mr. Lapin gave the paper. The two problems were said to be related only in that, in the past, both had been generally handled only by

* Part I of this paper is contained in the July issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

engineering experience. Fuel sloshing was the term used for aircraft motions resulting from fuel movements in the tanks. Work of E. W. Graham was described in which it was shown that, for small motions, the fuel in the tank could be replaced by a fixed mass plus a simple pendulum. A spring-mass system is an alternative that was used in studying the longitudinal motion of an aircraft with one partially full tank. A new motion, described as a fore-and-aft pulsing, was found to exist. A general description of the buffeting problem was also given, and it was indicated that it is an aeroelastic response problem that should be susceptible to analysis. This may require that concepts from turbulence and the mechanics of stochastic processes should be used to develop a rational buffeting theory.

Design

The design session held in the evening of June 27 was intended to bring out discussion of recent developments in jet-propelled vehicles. Design problems of a research rocket and the present status of operational experience of turbojet transports were the subjects taken up. **Willis M. Hawkins, Jr.,** Division Engineer—Preliminary Design, Lockheed Aircraft Corporation, was chairman. He was introduced by **Holley Dickinson,** member of the Program Committee.

The first paper of the Design Session was "The Viking Rocket," given by **W. G. Purdy,** The Glenn L. Martin Company. The design aims, performance, history, and operational difficulties encountered during the Viking development period were reviewed. The Viking, sponsored by the Office of Naval Research, is a slender, fin stabilized, upper air research rocket. The trajectory is nearly vertical and includes over 5 min. of flight above 130,000 ft. altitude. Its motor burns alcohol and liquid oxygen, which are supplied by a steam driven pump. Twenty thousand pounds of thrust are available for 75 sec., providing an acceleration to a speed of greater than 5,000 ft. per sec. Reaction Motors, Inc., designed and built the power plant. During the burning portion of the flight, the gimbal-mounted motor is used for pitch and yaw steering, while exhaust steam from the turbine is ducted to nozzles near the fin tips to provide roll control. During coasting, small jets utilizing some of the unused pressurizing gas provide control. Data are obtained by telemetering and from photographic records recovered in the wreckage. Explosive charges break the vehicle into high drag pieces to lessen the severity of ground impact. The pay load has been up to 900 lbs. Six Vikings have been fired, one reaching 107 miles altitude and another reaching 105 miles after being fired from the deck of the U.S.S. "Norton Sound" at sea. The launching is shown in Fig. 1.

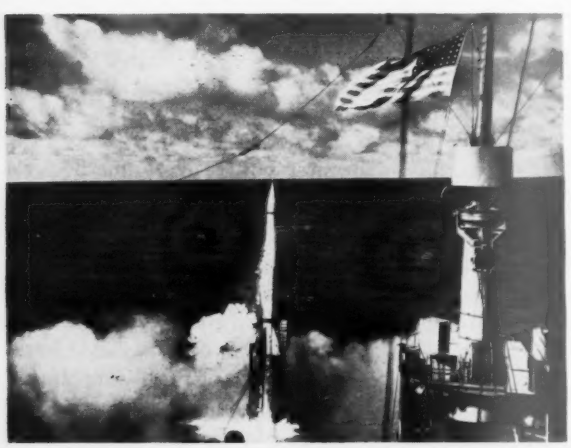


FIG. 1. Launching of Viking Rocket from U.S.S. "Norton Sound."

A review of performance potentialities and operational problems of turbojet transports was presented by **R. Dixon Speas,** U.S. Representative, A. V. Roe Canada Ltd. Particular emphasis was placed on experience with the AVRO Jetliner. Sound movies of that airplane were shown to demonstrate the noise level outside the airplane, to show the difficulty of inadvertently starting fires with the hot jet, and to show taxiing operations at busy airports. Detailed data on the Jetliner's cross-country flights were shown, including both performance and meteorological information. A general discussion of jet-transport operational requirements was given from the point of view of the air transport operator.

Propulsion Problems in Aircraft Design

Members and guests attending the June 28 morning session heard four papers, which covered late developments in aircraft propulsion installation problems. **Col. Marvin C. Demler,** Chief, Aeronautics Division, Air Development Force, Wright-Patterson Air Force Base, was session chairman. He was introduced by **Harold Luskin,** Program Committee Chairman.

The first paper in the Propulsion Session was "Ejectors for Cooling a Turbojet Installation" by **H. C. Towle** and **F. V. H. Judd** of Republic Aviation Corporation. Mr. Towle presented the paper. It was said that the requirement of a cooling air ejector is to pump sufficient cooling air at a minimum loss of thrust. Considerable data are available for ejectors for pumping large amounts of secondary flow, but relatively little data for ejectors with a large primary flow and relatively little secondary flow are available. The paper furnished little design data on this subject but described some experimental model tests that enabled the authors to deduce an elementary understanding of the phenomena occurring and the trends involved. It was shown that the large suctions observed are achieved by what amounts to an overexpanded supersonic nozzle, and the no-flow suctions observed were predicted on this basis. The authors indicated this correlation between experiment and theory applies only to ejectors with parallel mixing sections. They concluded that parallel-walled ejectors are more sus-

ceptible to design and less critical to geometrical parameters, so that their efforts were channelled in this direction. Some data on the effect of the ejector on thrust observed on the F-84 airplane were given. Static tests indicated that scale measurements gave rather good correlation with thrust measurements calculated on the basis of rake measurements ahead of the mixing sections. On the basis of these measurements, the authors redesigned the ejector and realized a sizable (200 lbs.) gain in airplane thrust. The authors concluded that ejectors having minimum suctions and area ratios will produce the least thrust penalty and that further ejector tests data are required. This would allow one to design ejectors that would not overcool and, thereby, cause large thrust penalties. (This paper was published in the September issue of the REVIEW.)

The problem of heating of aircraft surfaces that are near exhaust jets was treated in the paper, "On the Interaction Between Multiple Jets and An Adjacent Surface," presented by **Julius Jonas,** Supervisor, Thermodynamics, Northrop Aircraft, Inc. The author described a small-scale experimental apparatus used to investigate the degree of heating for the F-89 airplane. A small-scale hot single jet was set up in proximity to a flat plate, representing a fuselage, on which the surface temperature could be measured. A second and third jet were simulated by installing reflecting plates on each side of the single jet and measuring the effect on the flat plate. Data were presented which indicated the heating problem increased somewhat when additional jets were simulated. The tests were run in quiescent air and showed the overheating problem was most acute at sufficient downstream distance for the jets to spread. The tests indicated only a small effect of gas temperature on the nondimensional temperature rise parameter distribution. The author stated that subsequent tests of the F-89 airplane showed good agreement with the model tests. It was also stated that flight tests indicated that the effect of the moving air stream (due to airplane motion) was to intensify the heating in some regions and to produce cooling effects in other regions.

A problem of importance in turbojet-powered airplane performance prediction was considered by **De Marquis D. Wyatt,** Lewis Flight Propulsion Laboratory, N.A.C.A., in the paper "Aerodynamic Forces Associated with Inlets of Turbojet Installations." Mr. Wyatt's concern was with the estimation of thrust and drag at supersonic speeds, where he showed that the conventional definitions are not consistent. It is necessary to begin by considering the momentum theorem. This consideration verifies subsonic practice but indicates also the need for including a new term at supersonic speeds. Methods for handling the new term, estimates of its magnitude, and a discussion of scoop pressure drag completed the paper. Inlets considered are shown in Fig. 2 of Mr. Wyatt's paper, which is published elsewhere in this issue.

The first, and probably most important, part of the design task of making a power-plant installation is the proper selection of the plant itself. The paper, "The Generalized Approach to the Selection of Propulsion Systems for Aircraft," by **L. R. Woodworth** and **C. C. Kelber**, The RAND Corporation, gave an elaborate study, The problem. Mr. Kelber presented the paper, in which consideration was given to the following power-plant types: rocket, ram-jet, afterburning turbojet, turbojet, ducted fan, turboprop, and reciprocating. The method used was one in which a figure of merit is developed in terms of the performance and application requirements of the aircraft. The power-plant size, weight, and fuel consumption characteristics are related to the airplane properties in simplified endurance equations. Electronic calculating machines are then used to evaluate the power plants. The criterion used was the maximum endurance, which was equivalent to least weight of power plant plus fuel. Conclusions were drawn which showed optimum regions of application for some of the power-plant types.

Design and Structures

The final technical session considered a variety of design and structures problems. **Professor Alfred S. Niles** of Stanford University acted as chairman. He was introduced by **Walter Hurty,** member of the Program Committee.

The introduction of the automatic pilot in aircraft created the possibility of violent maneuvering following certain types of autopilot failure. If that happened when the pilots were not strapped into their seats, complete loss of the aircraft could follow. This actually happened in 1949 and prompted the work described in the paper, "Autopilot Flight Tests of the Constellation," by **R. L. Thoren** and **W. L. Howland,** Lockheed Aircraft Corporation. The paper was presented by Mr. Howland. The history of the problem was reviewed, together with a discussion of possible types of autopilot failures and malfunctions. The effect of a power boost system on the autopilot characteristics was taken up, and the structural aspects of the problem were discussed. The Lockheed flight-test program was described, and detailed data from typical maneuvers were shown in slides. The paper ended with the conclusion that proper design and testing can make the airplane almost completely safe from autopilot malfunction.

There has been considerable use of wing tip tanks on military aircraft recently. This has stimulated study of the flutter problem for such configurations. An experimental and theoretical investigation into the antisymmetric flutter characteristics of a straight wing having a number of tip-pod configurations was described in a paper by **William H. Gayman,** Dynamics Research Engineer, Northrop Aircraft, Inc. The paper's title was "An Investigation of a Varying Tip Weight Distribution on the Flutter Characteristics of a

(*Continued on page 32*)

Aerodynamic Forces Associated with Inlets of Turbojet Installations

De MARQUIS D. WYATT*

National Advisory Committee for Aeronautics

Introduction

THE CORRECT CONSIDERATION OF THE FORCES acting on a turbojet engine installation is obviously a problem of major importance in the design and performance estimation of new aircraft. Basically, the problem is straightforward and should cause no concern. In common with many basically simple problems, however, the fundamental aspects of the force analysis problem have become obscured by the use of conventional definitions. When the conventional definitions are applied to regions outside their original scope, confusion often arises in the allocation of important forces as either thrusts or drags, with the confusion in some cases leading to total neglect of these forces. In the present paper an attempt will be made to relate conventional definitions to fundamental force concepts through a summary of existing analyses.

Engine-Nacelle Configuration

In the interests of simplicity, let us first consider an isolated turbojet engine and nacelle operating in an inviscid fluid at 0° angle of attack (Fig. 1). The nacelle inlet will be considered to be operating at a mass-flow ratio less than unity.

In the absence of viscous forces, the net axial or propulsive force on the engine-nacelle configuration must equal the sum of the axial components of the pressure forces on all surfaces. Thus the propulsive force F_N may be expressed as

$$F_N = \int_{A_i} (p - p_0) dA - \int_{A_e} (p - p_0)\, dA \quad (1)$$

where A_i and A_e refer to the normal projected areas of the internal and external surfaces, respectively. The sign convention has been chosen to give F_N a positive value in the thrust, or forward, direction.

Let us now examine the relation between the propulsive force defined by Eq. (1) and the force yielded by conventional drag and thrust definitions. The pressure drag of a nacelle, D, is conventionally defined as the axial component of the pressure integral over the external surface and, hence, is exactly equivalent to the last term of Eq. (1) or

$$D = \int_{A_e} (p - p_0)\, dA \quad (2)$$

The thrust of a jet engine is conventionally defined as the difference in total momentum between the outlet and the free stream ahead of the inlet, where the pressures are relative to free-stream static or

$$T = mV_2 + A_2(p_2 - p_0) - mV_0 \quad (3)$$

The thrust definition of Eq. (3) can alternatively be expressed as the sum of the total momentum changes from the outlet to the inlet and from the inlet to the free stream. Since the momentum change from the outlet to the inlet is exactly equal to the axial component of the pressure integration over the inner surface, Eq. (3) may be rewritten as

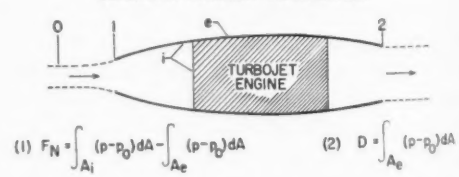
$$T = \int_{A_i} (p - p_0)\, dA + m(V_1 - V_0) + A_1(p_1 - p_0) \quad (4)$$

Substitution of Eqs. (2) and (4) into Eq. (1) yields an expression for the propulsive force of the installation as

$$F_N = T - D - m(V_1 - V_0) - A_1(p_1 - p_0) \quad (5)$$

It is seen from Eq. (5) that, although it is normally considered that the propulsive force is equal to thrust minus drag, such is not the case when the inlet total momentum is different from the free-stream total momentum. This condition obtains whenever the mass-flow ratio of the inlet is different from unity.

In inviscid subsonic flow, however, it is well known that the drag on a closed body is zero. This theorem can be extended for an engine-nacelle configuration



(1) $F_N = \int_{A_i} (p-p_0)dA - \int_{A_e} (p-p_0)dA$ (2) $D = \int_{A_e} (p-p_0)dA$

(3) $T = mV_2 + A_2(p_2-p_0) - mV_0$

(4) $T = \int_{A_i} (p-p_0)dA + m(V_1-V_0) + A_1(p_1-p_0)$

(5) $F_N = T - D - m(V_1-V_0) - A_1(p_1-p_0)$

FIG. 1.

Presented at the I.A.S. Annual Summer Meeting, Los Angeles, June 27–28, 1951.

* Assistant Chief, Supersonic Propulsion Division, Lewis Flight Propulsion Laboratory.

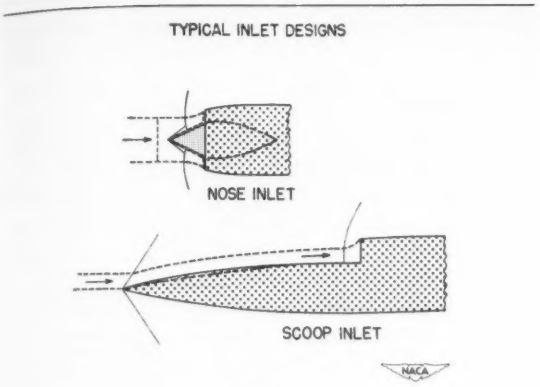


FIG. 2.

when the discharge or exit pressure is equal to the ambient pressure to show that the sum of the pressure integrals over the streamline bounding the inlet flow and over the external nacelle surface must yield zero axial force.[1] (The external nacelle surface, in this case, also includes all internal surfaces ahead of the stagnation point at the inlet.) The change in total momentum from the inlet to the free stream [last two terms of Eq. (5)] is exactly equivalent to the pressure integral along the streamline. Thus, from subsonic inviscid theory the sum of the last three terms of Eq. (5) is zero, and the propulsive force, neglecting viscosity, on a subsonic engine installation is simply the thrust as conventionally defined. (This theorem is limited to nacelle inlet Mach Numbers less than the critical value. When the critical Mach Number of the inlet is exceeded, shocks in the imbedded supersonic field result in a finite drag for the streamline-nacelle system.)

Although the change in momentum from the inlet to the free stream does not have to be considered at subsonic speeds if the nacelle pressure drag is simultaneously ignored, it is not possible to neglect the resultant force at supersonic speeds. Even with a mass-flow ratio of unity in the nacelle, a finite pressure drag exists on the nacelle such that the sum of the pressure integrals on the streamline and nacelle does not equal zero.

Inasmuch as the momentum change from the inlet to the free stream must be considered in force analyses at supersonic speeds, it will be advantageous to allocate the resultant force on a thrust or a drag. The choice is arbitrary. If the conventional thrust definition of Eq. (3) is considered to be an absolute definition of thrust, then the force must be considered a drag. If, on the other hand, it is considered that drag must be wholly represented by pressures on the external surface, then the force must obviously be a thrust. Although the choice is arbitrary, several factors lend support to its definition as a drag. First, the resultant force generally acts in a drag direction. Second, the force arises from the installation of the engine in the nacelle rather than from the engine itself and, therefore, is largely under the control of the aerodynamicist, whose chief concern may be regarded as drag. For these reasons the resultant force will be regarded as a drag in the present paper. The force exists only as a necessary correction to make the forces predicted by conventional thrust and drag definitions compatible with the actual physical forces acting on the configurations.

The corrective drag concept just derived is not new. In fact, enough time has elapsed that several conventional expressions for this drag have entered the field. Unfortunately, these conventionalities were originally derived for specific regimes and have in themselves been the source of some confusion. An examination of these conventional definitions is therefore in order.

CONVENTIONAL TERMINOLOGY

A typical annular nose inlet is illustrated at the top of Fig. 2. The projecting cone is generally considered to be part of the inlet, and the pressure forces on the cone are not conventionally considered part of the external drag of the installation. The total momentum at the inlet is therefore regarded as

$$\text{Inlet momentum} = \int \rho_i V_i^2 dA_i + \int (p_i - p_0) dA_i + \int (p_c - p_0)\, dA_c \quad (6)$$

where the subscript i refers to the projected annular area and the subscript c refers to the projected cone area. From a consideration of the momentum envelope bounded by the inlet (including cone projection), the bounding streamline of the inlet flow, and a plane normal to the inlet in the free stream, the difference between the inlet momentum from Eq. (6) and the free-stream momentum is equal to the pressure integral along the bounding streamline. When the change in total momentum from the inlet to the free stream can be so defined, Ferri and Nucci proposed that the resultant force be called the additive drag.[2]

When the cone is extended a considerable distance ahead of the inlet and the inlet only partly encompasses the body, a scoop inlet such as that illustrated at the bottom of Fig. 2 is obtained. The cone of the nose inlet has now become the fuselage, and the fuselage is not conventionally considered to be part of the inlet. The fuselage pressure forces are therefore retained as part of the external drag of the complete configuration. The corrective drag term required to establish compatibility between the conventional thrust and drag definitions and the actual forces on the configuration is identical with that of the simple nose inlet of Fig. 1 and the annular inlet at the top of Fig. 2; however, this force is no longer equivalent to the pressure integral on the streamline bounding the inlet air flow and, hence, should not be called the additive drag. Klein has proposed that the change in momentum from the inlet to the free stream be called the scoop incremental drag in this case.[1]

It should be noted that the total scoop incremental drag associated with a given inlet operating condition

may be viewed as the sum of two terms. In the first place, the local region in which the scoop is installed may not be at free-stream conditions, and, therefore, a momentum difference from the free stream may exist irrespective of the inlet flow. This momentum difference, which must be considered as soon as the inlet is installed adjacent to the body and the conventional thrust definition is applied, may yield a positive or negative drag term, depending on the body shape and the inlet location. A second factor influencing the inlet momentum is related to the local streamline curvatures induced by the inlet design and operating condition. This latter term may be considered as a local additive drag and can be calculated from pressure integration along the local streamline or by equivalent momentum balances.

In summarizing the discussion of additive drag and scoop incremental drag, it may be said that scoop incremental drag is a general definition of the necessary corrective drag term; the additive drag is a particular and limited definition. The two definitions become identical whenever the change in momentum from the inlet to the free stream is wholly due to the inlet; they differ when part of the momentum change arises from sources other than the inlet.

Magnitude of Momentum Change

Having defined some of the conventional terminology surrounding the force analysis problem, the magnitude of the momentum change from the inlet to the free stream will be considered. Since only the drags associated with spillage induced by the inlet can be generalized and since these results are a partial solution to the scoop inlet configuration, the analysis to follow will consider only nose inlets. The term additive drag will therefore be applied to the resultant force.

The magnitude of the additive drag depends on the flow mechanism causing the spillage. Three schematic spillage mechanisms that are susceptible to analysis are shown in Fig. 3. As pointed out earlier, the additive drag is equal to the axial component of the pressure integral along the bounding entering streamline. The relative magnitudes of the additive drags associated with the flow mechanisms illustrated can therefore be estimated from the relative pressures on the entering streamline.

A detached bow wave produces a high pressure rise across the shock and leads to high pressures on the entering streamline. Therefore, the drag associated with this type of spillage should be high. The pressure rise across an oblique shock wave originating from a cone is relatively low, and the additive drag due to this flow mechanism should be comparatively low. The mixed oblique shock, bow-shock configuration is not immediately amenable tc philosophic analysis. The pressure along the bounding streamline may be greater or less than that for a simple bow shock, depending on the cone angle and the flight Mach Number.

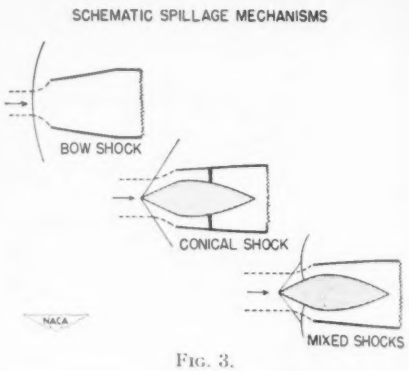


Fig. 3.

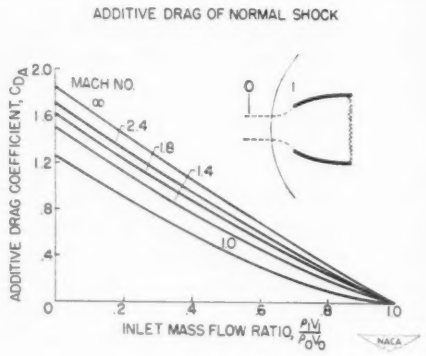


Fig. 4.

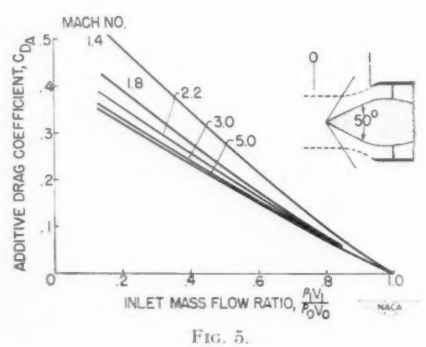


Fig. 5.

Quantitative calculations of the additive drag associated with these spillage mechanisms are presented in Figs. 4 to 6. Spillage through a bow shock has been evaluated in Fig. 4 by assuming the bow shock to be a normal shock in the vicinity of the entering flow and by assuming the inlet flow (station 1) to be one-dimensional. Under these assumptions, the change in momentum from the free stream to the inlet can be readily calculated, and, when expressed in coefficient form based on the inlet area, the additive drag becomes solely a function of flight Mach Number and inlet-mass flow ratio. It will be noted that the additive drag increases with an increase in flight speed and that a finite upper limit to the drag coefficient is obtained for an infinite forward speed.

The additive drag associated with spillage behind a conical shock is illustrated in Fig. 5 for flow on a 50° included angle cone. These data were calculated directly from the pressure integral on the entering streamline using cone flow tables.[3] For this type of spillage, the additive drag coefficient decreases as the flight Mach Number is increased—the reverse of the bow shock case. This is to be expected, inasmuch as the strength of the oblique shock decreases as the flight Mach Number is increased.

The relative additive drags for normal shock and conical shock spillage are compared in Fig. 6 with mixed flow spillage on a 50° included angle cone for a flight Mach Number of 1.8. The drag for the mixed shock configuration requires an approximation to the inlet flow and the pressure distribution on the cone. The drag obtained with the particular set of approximations used in the present analysis (proposed by M. Sibulkin, formerly of the N.A.C.A. Lewis Flight Propulsion Laboratory) is higher than normal shock additive drag for this particular Mach Number and cone angle. Both of these cases yield much higher drags than does conical shock spillage. The desirability of avoiding an external normal shock is evident.

For reference in evaluating the general level of magnitude of the additive drags indicated, comparison can be made to the theoretical pressure drag of a conical cowl of area ratio 0.4 and length-diameter ratio 4.0. Such a cowl would have a pressure drag coefficient based on the inlet area of only 0.035 at $M_0 = 1.8$ without spillage.[4] Thus the additive drag is of major importance in force allocation.

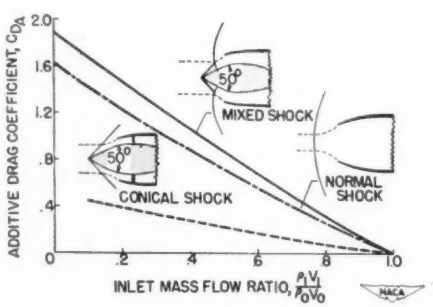


FIG. 6.

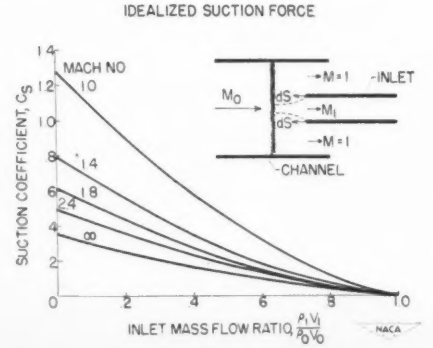


FIG. 7.

Fig. 5 shows that the additive drag coefficient decreases as the flight Mach Number is increased—the reverse of the bow shock case. This is to be expected, inasmuch as the strength of the oblique shock decreases as the flight Mach Number is increased.

The sum of the additive drag and cowl drag will not increase at the same rate as the additive drag illustrated on Fig. 6. With the normal shock inlet, for example, an imbedded subsonic flow region is formed in the vicinity of the inlet as the mass-flow ratio is decreased. This subsonic field yields a suction pressure on the cowl surface, which reduces the cowl pressure drag. Exact analytical methods for predicting this decrease in pressure drag are extremely difficult; however, an approximate generalization of the flow proposed by Graham[5] yields the essential elements of the problem. This simplified picture and the resultant suction forces are indicated on Fig. 7.

A hypothetical channel can be placed around a thin-walled cylinder representing the inlet, such that a normal shock can stand in the channel ahead of the inlet with sonic velocity between the inlet and the channel wall. Since the channel walls are parallel to the flow, a momentum envelope can be set up and the suction force S acting on the inlet lips can be calculated. Suction forces so calculated are presented in the form of suction coefficients based on the inlet area. These coefficients represent theoretical maximum values for a detached bow wave.

From the nature of the analysis, these coefficients exactly cancel the additive drag coefficients at sonic velocity (see Fig. 4) and decrease in magnitude as the flight Mach Number is increased. Since the additive drag coefficients for bow shock spillage increase with increasing Mach Number, the suction effect becomes proportionally lessened, in terms of overall forces, as the flight Mach Number is increased.

Conclusion

In summary, it has been shown that the conventional definitions for thrusts and drag do not predict the propulsive forces on an engine installation when the inlet mass-flow ratio is not unity. At subsonic speeds, the change in momentum from the inlet to the free stream can be disregarded in force analyses, however, if the nacelle pressure drags are also disregarded. At supersonic speeds such a procedure cannot be followed.

The change in momentum of the airflow entering the inlet has been related to the conventional definitions of additive drag and scoop incremental drag. It was shown that the additive drag represents a particular case, where all the momentum change of the inlet airflow arises from the inlet proper. Evaluation of the magnitude of the additive drag for several flow configurations shows the necessity for including this drag in any force analysis.

The suction force on the cowl lip which counteracts the additive drag was shown to be highly important at subsonic speeds but to be of lesser importance at supersonic speeds.

(*Continued on page 31*)

Pilotless A

At N.A.C.A.'s Pilotless Aircraft Research Station, Wallops Island, Va.

FIG. 1. A delta-wing research model is prepared for launching at the N.A.C.A.'s pilotless aircraft research station at Wallops Island, Va. Rocket-powered models such as this are used to obtain aerodynamic data on wing shapes, stability, control effectiveness, and other factors involved in designing high-speed airplanes.

Aircraft Research

by Welman A. Shrader*

Introduction

During World War II, reliable data on transonic flow conditions were virtually nonexistent and could not be obtained in wind tunnels. While much was known about supersonics even then, the aerodynamic effects at speeds just under, at, and slightly beyond the speed of sound were mostly a matter of guess. To the men who were called upon to design supersonic research airplanes, jet fighters, and guided missiles, the need for more information on this subject was paramount. It was this need that led to the development of the "bomb drop" and "free-flying rocket-model" techniques employed today.

In 1945, N.A.C.A. established its pilotless aircraft research station at Wallops Island, Va., where the testing and firing of rocket models could be carried out in secret. Since that date, more than 1,500 research models have been fired into the sea from this isolated sandy beach. The aerodynamic information obtained in these tests has proved extremely valuable in the design of today's jet fighters—as, for example, the Air Force's F-91 and XF-92A, the Navy's delta-wing XF4D, and ultra-fast airplanes such as the D-558-II, X-2, and X-3.

While the important work done at this station has been highly classified, it is now possible to reveal some of the results and the methods used. Particularly interesting is the major role played by electronics and the special electronic equipment that has been designed to make free-flying model testing possible.

The Models Used

The research models tested at Wallops Island are designed and constructed at N.A.C.A.'s Langley laboratories. Usually, the models do not resemble any specific airplanes but assume varied and unusual shapes. Occasionally, dynamic scale models of an extremely fast plane or missile that is still in the design stage will be built and tested for specific data.

Regardless of its shape or size, each model has one primary duty—i.e., to interpret the forces that act upon it in flight and transmit this information to the ground. Lift, drag, stability, control effectiveness, damping in roll, flutter, buffeting, boundary-layer phenomena, or even aerodynamic heating caused by skin friction with the air are but a few of the problems a single model may be called upon to solve during its minute or so of useful life.

This means extensive instrumentation with a myriad of subminiature electronic control, recording, and telemetering devices. As many as ten or more miniature radio "broadcasting stations"—each operating on a different frequency and sending back different types of information—may be carried aloft in a single model.

Obviously, instruments and models of this nature must be fabricated with extreme accuracy. Particular attention must be paid to weight distribution and balance. Many man-hours are required to build each

Fig. 2. This continuous-wave Doppler velocity radar unit provides a running record of the speed of rocket-powered models fired at the N.A.C.A.'s pilotless aircraft research station. The two operators track the rocket by sight, and later by sound through earphones, in order to keep their antennas aimed straight at it.

* Director of Publications, the Institute of the Aeronautical Sciences.

FIG. 3. A control panel operator at Wallop Islands is a busy man for a minute or two before he pushes the final button. Just before the rocket is shot, he checks numerous instruments to be sure the telemeter, recording apparatus, and all electric circuits are in working order. Temperature and humidity in this room are carefully regulated to protect electronic equipment.

small test model, but seldom is it necessary to construct and fire more than one model of a specific design. Since every model falls into the sea and is not recovered, this is a complimentary reflection on the degree of skill achieved by N.A.C.A. personnel in this work.

ROCKET MODEL LAUNCHING

In its rocket launchings at Wallops Island, the N.A.C.A. is seeking primarily aerodynamic data at very high speeds. The best shapes for wing, tail, and fuselage are usually in question. The facilities at this station do not constitute a missile test range like those at Point Mugu, Calif., White Sands, N.M., or Banana River, Fla. The rocket engine, itself, is not being tested; it merely provides power to launch a free-flying research model at extremely high speeds.

The rocket vehicles are launched from stands on the beach (Fig. 1). They pick up speed rapidly passing through the transonic and into the supersonic range within a few seconds. After attaining a top speed of approximately 1,600 m.p.h. and using all its fuel, the booster is pulled away from the model by drag. As the power of the booster is expended, a delayed fuse ignites the rocket charge imbedded in the model, and the model streaks away on its own.

Often, the model itself does not carry any rocket charge. This type of model is brought up to maximum speed by the booster alone. When the fuel is exhausted, drag pulls the booster away from the research model, which then glides freely through the air.

Some of the larger rocket-propelled models take off under their own power, without a booster. For some tests, a tiny research model is mounted on a balance projecting from the nose of a large rocket containing the instruments and powder charge.

The rocket-propelled research models soar to great heights and travel 5 to 10 miles before plunging into the sea several miles off shore. Most attain an altitude of 15,000 to 30,000 ft.; some fly as high as 100,000 ft. Top speeds range from 15 to 40 miles per min.; most of the models attain a speed of 20 miles per min. (1,200 m.p.h.). Usually the entire flight is completed in less than 2 min.; sometimes in only 30 or 40 sec.

During its flight, the model can be put through a series of programmed maneuvers simulating a wide range of flight conditions. It can roll, climb, dive, and turn like an airplane, exerting varying forces on the wing and tail surfaces. These maneuvers are accomplished by automatically actuating the controls in a predetermined manner. The control mechanism is set for the desired program before take-off.

HOW DATA ARE OBTAINED

The data sought are obtained during the entire flight of the model but especially while it is flying at transonic and supersonic speeds. Two types of radar, a Doppler velocity radar (Fig. 2) and a flight path radar, are used for tracking the model from the instant it is fired until it falls into the sea. Radar is used primarily to determine the location of the model in space and its velocity at any time during the flight. It also provides comparative data that can be matched with data telemetered from the model.

The various aerodynamic reactions, as measured by the pressure pickup instruments and controls installed in the model, are transmitted back to receiving stations on the ground throughout the entire flight. The telemeter unit, powered by tiny batteries, is turned on just before the rocket is fired. It transmits a running record of acceleration, position of the controls, forces on the controls, aerodynamic forces acting on the model (such as lift, drag, etc.), pressures acting on the surface of the model, attitude of the model in respect to the air stream, skin temperatures, etc.

FIG. 4. Technicians tune up the telemeter ground receiving station just before the flight of a rocket-propelled model. They are in communication by telephone with other operators and observers on the island. The telemeter equipment shown receives the radio signals transmitted from the model in flight and makes a permanent photographic record of the model's aerodynamic behavior during its high-speed flight.

FIG. 5. Here is shown the operation of the Doppler radar recorder during the flight of a rocket-propelled research model. High-speed cameras make a continuous recording of a cathode-ray oscilloscope screen to provide permanent records of the Doppler radar data. The Doppler unit, located near the launching stand, tracks the model by radar to obtain velocity and drag information.

RECORDING THE FLIGHT DATA

The radio receiving sets and recording apparatus, as well as the control panel for firing the rocket, are housed in a concrete building at the launching site (Figs. 3–6). Most of the records are made photographically on fast-moving strip film in such a manner that all results of the test are recorded graphically on the same film and can be compared in relation to time and distance. Data obtained at any point in the flight, both from the radars and telemeters, can be seen clearly in relation to all other test conditions. Even the distance the rocket has traveled from the launching stand can be calculated within a few feet at any point in the film.

Immediately after a model flight, a weather balloon is released carrying aloft a radio transmitter that sends back information on the temperature, humidity, and pressure of the air through which the model has just passed at various altitudes. These flight conditions are also taken into account in determining the flight characteristics of the model under test (see Fig. 7).

From the very start of one of these tests, every effort is made to obtain as much useful data as possible from a single flight. The techniques that have been devised make it possible to obtain complete measurements of lift, drag, stability, and control over the entire speed range from a single model. All of this information is obtained in a matter of seconds as the rocket-propelled model streaks through space.

BOMB-DROP TECHNIQUES

Another method developed by N.A.C.A. called the "bomb-drop" technique is used primarily for gathering transonic flow data. In this type of test, a research model is dropped from an airplane at a height of more than 30,000 ft. The model makes a free fall into the sea with the force of gravity pulling it through the transonic speed range. Data are obtained by radar tracking and telemetering in much the same manner described previously.

This falling-body technique has proved particularly useful in making tests of flutter and drag in the transonic speed range. The purpose of the drop tests is to learn at what Mach Numbers changes occur in the airflow. Models of ram-jet engines also have been successfully tested by this method.

REDUCING THE DATA TO USABLE FORM

Data are recorded in many forms from the instrumentation used in rocket firings at Wallops Island. The telemetering information obtained from the model is recorded by oscillographs. Information gathered by the Doppler radar is recorded on a special magnetic tape, while that received through the position radar is in photographic form.

Since the research work done by N.A.C.A. is divided into both experimental and analytical phases, the re-

FIG. 6. This is a view of the spinsonde ground receiving station in operation during the flight of a rocket-propelled research model. The small radio transmitter in the model sends back a polarized wave that is received strongly or weakly by the ground station antenna, depending upon the rotational position of the model during flight. Control surfaces similar to an airplane's ailerons are preset on these models so that they cause the model to roll rapidly. The rate at which the model rolls is an indication of the effectiveness of the control surfaces.

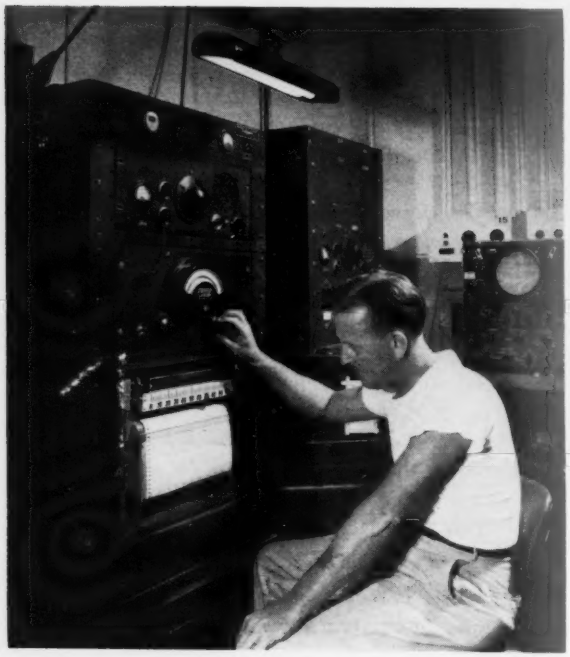


FIG. 7. Immediately after a model flight, a weather balloon is released carrying aloft a radio transmitter that sends back information on the temperature, humidity, and pressure (density) of the air through which the model has just passed at various altitudes. These flight conditions are taken into account in determining the flight characteristics of the model under test. In this photo, the technician is operating a radiosonde receiving station that receives broadcasts from the weather balloon.

duction, integration, and processing of these data are a tremendous task. Data measurements by the thousands are yielded from a single rocket-model firing. To reduce all of this information to usable form manually would require a lifetime. It has been necessary, therefore, to bring numerous types of automatic, high-capacity recording, and calculating devices into the picture.

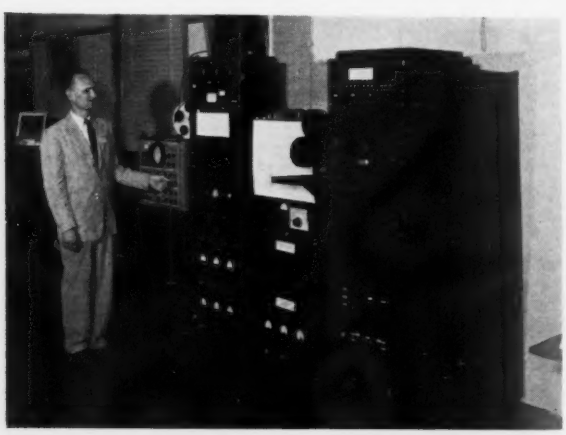


FIG. 8. In the reduction of data from rocket-propelled model tests, this Doppler Digital Chronograph is used to convert the displacement record from a Doppler radar to a time history of velocity in digital form. The Doppler radar signal and time base are recorded on magnetic tape and then played into this electronic cycle counting equipment to obtain a record of velocity in digital form on film, from which I.B.M. cards are prepared. These cards, along with the cards covering pulse radar data, telemeter data, and radiosonde information are processed in I.B.M. calculators to provide the completely tabulated aerodynamic data on the flight.

FIG. 9. The N.A.C.A. laboratories make extensive use of this oscillograph record reader device for converting oscillograph records to I.B.M. cards that are then processed through usual I.B.M. machinery.

I.B.M. electronic card-programmed calculators, Bell digital computers, and Reac, Philbrick, and other types of analog machines are used (Figs. 8–10). The laboratories also make use of high-capacity computing machinery at other Government, commercial, and university locations.

In planning the instrumentation for model testing, first consideration is always given to the primary requirements of accuracy, stability, reliability, size, and

FIG. 10. The model and chart set up above this machine graphically illustrate how the solution of an equation of lateral motion is obtained from a Reac Recorder.

complexity. Then the processing of the data is planned to meet the obvious, but sometimes difficult, condition that no sacrifice in accuracy can be tolerated in the reduction. The economic aspect from the point of view of both money and personnel is always a factor. The system must be continually examined and inspected to strike the proper balance between the requirements, the quality, and the cost in dollars and people.

The reduction of the data involves far more than the use of extensive and speedy numerical computation machinery. The series of operations include editing, fairing, plotting, and proper storage. The systems for taking and reducing these data are continually becoming more automatic. However, the techniques for converting the intelligence to a form that can be used by automatic computing machines have not kept pace with the machines.

Relative to the type of numerical computations required, there is in general a great contrast between the long and involved mathematical processes required in analytical work and the computations required in the reduction of data. In the latter case, simple calculations usually are performed on a tremendous number of points. Many steps not usually considered to be data reduction really are a necessary and important part of the process. The relative ease of carrying out the various steps leads to a strong program on aspects of the work other than the actual computation process. These include:

(1) The improvement of the linearity of the instrumentation system to simplify and reduce the data reduction effort.

(2) The provision of adequate quality data during the tests may limit the data reduction required by reducing unwanted tests.

(3) The provision for proper editing offers a necessary and powerful control on quality. Editing of final tabulated data may be inadequate. An illustration is the case where aerodynamic data result from combining radar, Doppler, radiosonde, and telemeter data. Editing of the individual inputs is highly advisable. Similar reasoning leads to fairing prior to the final data. The many various forms that data are in require a corresponding variety in fairing techniques.

(4) The provision of instruments that do a certain amount of combining and computing, thereby providing a more advanced form of data. As illustrations:

(a) *Pressure Diagram Manometer*—Mechanical-optical pressure capsules project on still or motion-picture film the pressure diagram at a given chord line.

(b) *Pressure Integrators*—Electric pressure gages are combined through weighting networks to provide normal and chord force directly. Such integrators have been used in wind tunnels, in aircraft flight, and as a part of the telemeter system in rocket-powered model tests.

(5) The provision of automatic and semiautomatic procedures to carry out some of the various required steps in the data processing. As illustrations are: (a) record reproducing devices with means of changing scale in both directions; (b) automatic or semiautomatic plotting devices; (c) special reading aids to fit the variety of forms of records; and (d) automatic equipment to process magnetic tape recordings of Doppler radar.

(6) The funneling of all correlated data through a single automatic computing system. As an illustration of this, *all* data from the rocket-powered model tests are carried to aerodynamic coefficients through the use of I.B.M. machinery. The process requires the combined use of telemeter, Doppler, radiosonde, and pulse radar.

Until the art of instrumentation has progressed to a point where adequate fully automatic systems are available, reduction of data will lean heavily on many of these steps that are a necessary adjunct to the numerical computing process. However, proper planning may effect savings that are really considerably greater than the savings resulting from doing the actual numerical computation automatically.

Birthplace of Tomorrow's Airplanes

Since it usually requires about 5 years to design, develop, and put into service a new military airplane, the data currently gathered at Wallops Island and originated and analyzed at Langley laboratories will determine the appearance and performance of our future aircraft and guided missiles. Much credit goes to the 75 N.A.C.A. engineers and scientists who operate this isolated firing-range and to the personnel at Langley for their skill, ingenuity, and devotion to this work.

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A Report on the First U.S. National Congress of Applied Mechanics

*By Nicholas J. Hoff**

THE FIRST U.S. NATIONAL CONGRESS of Applied Mechanics was held in Chicago June 11–16 and was a great success in every respect. One hundred and thirty-seven technical papers were delivered; there were also short presentations before the Division of Fluid Dynamics of the American Physical Society held concurrently with the congress and general lectures. The total registration was 605 and included almost all the better known American research men working in the fields of applied mechanics. The organization was excellent; every paper began and ended exactly as scheduled on the program. It was possible, therefore, to listen to individual papers presented at the various simultaneous sessions instead of attending complete sessions. Most of the lectures were given in the recently completed beautiful and modern lecture halls of the Illinois Institute of Technology, which was host to the congress.

HISTORIC BACKGROUND

The idea of holding a national congress was promoted vigorously by Martin Goland of the Midwest Research Institute, who had been active both in the American Society of Mechanical Engineers and the Institute of the Aeronautical Sciences. He was supported by Dr. N. M. Newmark of the University of Illinois, who acted as spokesman for the civil engineers. Their proposals were discussed by the U.S. National Committee on Theoretical and Applied Mechanics, a joint committee of the American Society of Mechanical Engineers, American Institute of Chemical Engineers, Society for Experimental Stress Analysis, American Society of Civil Engineers, Institute of the Aeronautical Sciences, American Mathematical Society, and the American Physical Society. Under the chairmanship of Dr. Hugh L. Dryden of the National Advisory Committee for Aeronautics, it was decided that national congresses would be held under the sponsorship of the U.S. National Committee on Theoretical and Applied Mechanics at approximately four-year intervals, between the International Congresses of Applied Mechanics.

The organization of the first U.S. National Congress of Applied Mechanics was entrusted to Dr. Lloyd H. Donnel of the Illinois Institute of Technology, who was made general chairman of the Congress. He was supported by Martin Goland, chairman of the finance committee, Dr. N. M. Newmark, general secretary, and Dr. Eli Sternberg of the Illinois Institute of Technology, chairman of the editorial committee and editor of the proceedings.

There are two reasons why national congresses should be held in this country. First, the increased emphasis on, and availability of, funds for research have resulted in such a rapid accumulation of research information that the formal interchange of ideas every four years has become most desirable. Moreover, the various scientific and engineering societies have been competing for the participation of research men in their individual meetings often held at the same time or approximately the same time. It was hoped that the establishment of a single clearing place for new ideas in applied mechanics would do away with the overlapping meetings of the various societies and would enable the expert to bring his knowledge up to date without spending several weeks in travel from one meeting to another. The success of the first congress gives the writer hope that in the year of the next national congress the programming of the national as well as local meetings of the major societies will be centered around the National Congress of Applied Mechanics and will not interfere with it.

International congresses cannot fulfill the above-stated needs of this country for the obvious reason that comparatively few Americans have the opportunity to take part in them. Extreme care was taken to avoid all interference or competition with the international congresses. The national congresses were scheduled to be held between the years of the international congresses, and participation by foreign societies was excluded. Individual authors from

* Head, Department of Aeronautical Engineering and Applied Mechanics, Polytechnic Institute of Brooklyn.

abroad were admitted on an equal basis with those residing in this country; any paper could be included in the proceedings of the Congress if accepted by the editorial committee and presented orally at the congress.

Papers Presented

The subjects treated in the sessions included the failure of materials, friction, the theory of elastic plates, creep, photoelasticity, numerical methods of analysis, plasticity, thermal stresses, heat transfer, thermodynamics, hydrodynamics, theory of elastic shells, limit design, experimental methods, flow through porous media, three-dimensional elasticity theory, skin friction, kinematics, column theory, aeroelasticity, boundary-layer theory, turbulence, cavitation, nonsteady and hypersonic aerodynamics, the damping of vibrations, nonlinear vibrations, wave-front phenomena, impact, lubrication, and ballistics.

The general program of the national congress was patterned after the successful international congresses. It included a small number of general, invited lectures by outstanding research men. Dr. E. Orowan of the Massachusetts Institute of Technology talked on creep phenomena in metals and polymers; Dr. Max Jacob of the Illinois Institute of Technology gave a lecture on the relationship of heat transfer to mechanics and other branches of science; Dr. R. von Mises of Harvard University discussed the fundamentals of fluid flow theory, and the topic of Dr. J. N. Goodier of Stanford University was the theory of elastic stability. Dr. Th. von Kármán of Columbia University was prevented by illness from delivering a talk on the foundations of high-speed aerodynamics. His paper was presented by Dr. Frank L. Wattendorf of the U.S. Air Force.

Social Events

On the first day of the congress, an informal reception was held in the Student Union of the Illinois Institute of Technology for the members of the congress and their families. In the middle of the week, an excursion was organized to the Technological Institute of Northwestern University in Evanston. The congress banquet was held at the Shoreland Hotel and was attended by about 100 persons. A citation was read honoring Dr. von Kármán on his seventieth birthday and notifying him of his election as honorary president of the international mechanics organization. Dr. J. M. Burgers of the University of Delft, Holland, Secretary of the International Union of Theoretical and Applied Mechanics, of which the U.S. National Committee is an adhering organization, made a report on events in the international sphere. It was announced that the next national congress would be held at the University of Michigan in Ann Arbor in 1954.

In no small measure, the success of the Congress was due to the support given to it by the universities located in the Chicago area. The sponsoring institutes were the Illinois Institute of Technology, Purdue University, Northwestern University, the University of Illinois, and the University of Michigan. The individual needs of the members of the congress were catered to by the arrangements committee under the chairman, A. Cowie, and the secretary, D. F. Muster. The American Society of Mechanical Engineers and the editor of the *Journal of Applied Mechanics*, Professor John M. Lessels, of the Massachusetts Institute of Technology, made it possible to print a complete set of abstracts of all the congress papers in advance. The abstracts will be published in the September, 1951, issue of the *Journal of Applied Mechanics*.

Proceedings

One of the most important achievements of the congress will be the publication of its proceedings. The bound volume will contain approximately 100 papers in full, and it will be edited, printed, and illustrated with the same care and excellence of workmanship as the technical publications of the American Society of Mechanical Engineers. The Society and its secretary, Colonel C. E. Davis, have made it possible for the Congress to establish such a permanent record of its activities and, in this way, to contribute to the literature of applied mechanics in the United States. Subscriptions are still accepted at the prepublication rate of $10 by D. F. Muster at the Illinois Institute of Technology and by S. A. Tucker in the New York office of the American Society of Mechanical Engineers.

Aerodynamic Forces Associated with Inlets of Turbojet Installations

(*Continued from page 23*)

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Technical Sessions–Annual Summer Meeting

(*Continued from page 19*)

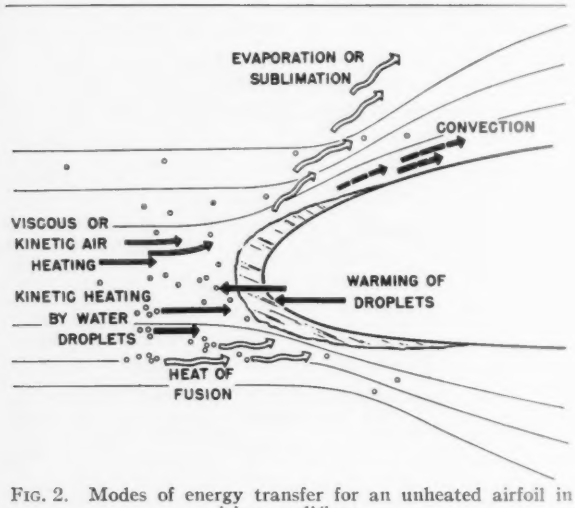

FIG. 2. Modes of energy transfer for an unheated airfoil in icing conditions.

Straight Wing." The experimental part of the program was conducted in a wind tunnel on a low-speed flutter model of the F-89 wing. Movies of some of the configurations were shown in which the fuel motion in the tip tanks was seen to be unusual. The theoretical methods for handling the problem were reviewed, and comparisons were made between the analytical results and the test data. Mr. Gayman concluded with some remarks on the reliability of practical methods for investigators faced with similar problems.

The increase in flight speeds made possible by jet propulsion has raised the question of the effect of aerodynamic heating on deicing requirements. Developments in the field of ice removal have included the idea of applying cyclical heat deicing to aircraft surfaces. A study of these questions was described by **Bernard L. Messinger,** Group Engineer, Thermodynamics, Lockheed Aircraft Corporation, in a paper entitled "Equilibrium Temperature of an Unheated Icing Surface As a Function of Air Speed." The problem was described, the heat transfer equations were discussed, and a diagram was shown which indicated the several modes of heat transfer occurring. This is shown in Fig. 2. The results of the work are shown in a series of graphs that allow determination of surface temperature, the speed beyond which icing will not occur, and the rate of sublimation for an ice-covered surface emerging into clear air. It was pointed out that extremely high flight speeds of over 700 m.p.h. are required to prevent collection of at least some ice.

Work on aeroelastic problems has been of increasing importance as aircraft and missiles have tended to increase their speeds. The closing paper of the 1951 I.A.S. Summer Meeting recognized this importance. It was "On the Deflection of Swept Cantilevered Surfaces" by **Prof. Harold C. Martin** and **H. J. Gursahaney** of the University of Washington. This paper was concerned mainly with deflections, although stresses and dynamic characteristics were also discussed. The main goal was to find an elementary method for predicting the characteristics of swept cantilevered surfaces. Tests of plates with various tapers at several sweep angles showed that, except near the clamped edge, an axis exists which has no deflection under application of pure twisting moments. This suggested the possibility of creating an equivalent beam to replace the plate, the beam lying on the axis of no deflection. The properties of the beam, being readily calculated, provide the desired answers. Experiments verified the approach. The method was said to be useful only for moderate and high aspect ratios.

The meeting was closed by Professor Niles.

Attention Members!

All members of the Institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review*. Responsibility for new developments, awards or honors received, and appointments to new or additional positions are some of the items that your editors believe are of interest to other I.A.S. members. A brief letter or postal card giving exact details will be sufficient. Photographs accompanying news items will be welcomed and will be used where practicable.

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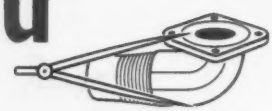

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I.A.S. Previews

Summaries of Current Papers Accepted for I.A.S. Publications

Horizontal Tail Loads in Abrupt Pull-Ups from Level Flight

By

James L. Decker

The Glenn L. Martin Company

A method is presented for the calculation of horizontal tail loads in abrupt pull-ups from level flight. The method is also applicable to push-over maneuvers. The basis of the procedure is the rational specification of the variation of load factor with time in the maneuver. The elevator deflection required to produce this airplane response is then calculated for the determination of the maneuvering tail load.

The airplane response is shown to be a function of the maximum elevator deflection rate in the maneuver. This becomes the sole arbitrary variable in the method and has been tentatively correlated against the airplane limit load factor and flight speed.

The calculations are appreciably shorter than those entailed in existing methods, and, since only one arbitrary variable is present, it is believed that calculations for various airplanes can be carried out on a more consistent basis.

The Classification of One-Dimensional Flows and the General Shock Problem of a Compressible, Viscous Heat-Conducting Fluid

By

Geoffrey S. S. Ludford

Harvard University

Recently a great deal of attention has been focused on the problem of determining the structure of a shock wave in a perfect gas on the basis of the Navier-Stokes equations. In this paper we shall denote by "perfect gas" a viscous, heat-conducting fluid that satisfies the equation of state $p = gR\rho T$, whose specific heats are, in general, functions of temperature. Becker was the first to consider the exact structure for a case where the Prandtl Number is neither zero nor infinite. His analysis was restricted to constant specific heats, constant coefficients of heat conduction and viscosity, and constant Prandtl Number = $^3/_4$. After him, several authors have attempted to solve the problem under more general conditions. Since the first approximate discussion by Taylor, other approximate methods have been developed. In some cases the Navier-Stokes equations were reduced to an ordinary differential equation of higher than the first order; in others, the reduction of Becker to a first-order equation was used. The approximate methods resort directly to the Navier-Stokes equations.

It was von Mises who reformulated Becker's approach and thus gave not only a much simpler presentation of the shock problem, but also a method of reviewing the general characteristics of all possible one-dimensional steady motions. It is the purpose of this paper to show that if the Navier-Stokes equations for the flow of a perfect gas are taken as a basis, then the method of review given by von Mises enables a complete classification of the flows to be made. Moreover, a discussion is presented of the problem of the shock wave in more than one dimension, which shows that a fuller numerical treatment of von Mises' equations and not a new approximation is needed in this case.

The Effect of Flight and Configuration Variables on Thermal Stresses in Diamond-Shaped Supersonic Wings

By

Franklin P. Durham

University of Colorado

For aircraft traveling at high supersonic speeds, approximate stagnation temperatures exist in the boundary layer surrounding the aircraft. If the aircraft has accelerated rapidly to a high supersonic speed, large transient temperature gradients will be introduced which may, in turn, cause high thermal stresses.

Methods for the determination of the transient temperatures and the stresses resulting from these temperatures are presented for solid diamond-shaped airfoils. Numerical results are given, showing the effects of several flight and configuration variables based on a wing of given specifications.

It is shown that the maximum thermal stresses occurring in the chosen wing are compressive stresses at the leading edge. It is further shown, for the severe flight conditions assumed, that these stresses are of large magnitude.

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Velocity and Temperature Distribution Through the Laminar Boundary Layer in Supersonic Flow

By

Carlo Ferrari

Cornell Aeronautical Laboratory, Inc.

The laminar boundary layer in a compressible gas is studied in order to obtain the velocity and temperature distributions through the layer in the presence of any pressure distribution whatsoever for the external flow, under the usual assumptions that the pressure is constant through the layer and that the temperature of the constraining surface is constant throughout its extent. The contour of this surface is supposed to be so gently turning that the surface elements may always be considered aligned with the free-stream flow.

The method described is well suited for routine computations. Even though it makes use of successive approximations, only one extensive recomputation is required; after the second approximation is obtained, further approximations, if desired, are carried out by means of short cuts that reduce the labor involved to less than one-tenth of that required in the first recomputation.

A significant effect of scale on the pressure changes in the potential flow exterior to the boundary layer is observed, although the magnitude of the changes in these external pressures is small in the example selected for numerical illustration of the theory.

I.A.S. News (Continued from page 7)

Necrology (Continued)

Mr. Holbrook was associated with Mississippi State College for a time as an Instructor in Aeronautical Engineering. He left there to take up his studies at Purdue University, from which he was recently graduated with a Master's degree.

He is survived by his parents, Dr. and Mrs. C. Tyler Holbrook.

W. Wallace Kellett

William Wallace Kellett, I.A.S. Founder Member and Associate Member, died on July 22 in the Hannemann Hospital, Philadelphia, after a brief illness. He was 59 years old.

A Bostonian by birth, Mr. Kellett attended the Chestnut Hill Academy and in 1913 was graduated from Princeton University with a Bachelor of Letters degree.

During World War I, Mr. Kellett served first as an ambulance driver with the American Field Service and later as a pilot in the French Army. Upon the cessation of hostilities, he was appointed the American Representative for H. and M. Farman for the purpose of selling Farman planes in the Western Hemisphere. From 1925 to 1930, he was President of B.B.T. Corporation of America. It was during this latter period that he invented the shadow-bar method of airport lighting and lighted the first American airway for night flying.

In 1929, Mr. Kellett organized the Kellett Autogiro Corporation (now Kellett Aircraft Corporation) and remained its President from then until his death. This company is believed to have built the first wingless aircraft in America. Ten years after the company's founding, Kellett instituted a daily mail service between Central Airport, Camden, N.J., and the roof of Philadelphia's General Post Office.

Mr. Kellett was first affiliated with Seversky Aircraft Corporation in 1938 as a Director. Shortly after this he became an Executive Vice-President and the following year was elected to the Presidency. In October of that year, the corporate title was changed to Republic Aviation Corporation. During Mr. Kellett's tenure of office, Republic underwent one of the most extensive expansions in the aircraft industry. He was elected Chairman of the Board in May, 1941, and 2 years later resigned to devote his full time to the Kellett Autogiro Corporation. He still retained, however, his position as Director at Republic.

Mr. Kellett also served during his professional career as Treasurer, Scialytic Corporation of America; Vice-President and Director, Central Airport, Inc., of Camden, N.J.; and Chairman of the Executive Committee, Ludington Airlines.

Mr. Kellett is survived by his widow, the former Virginia Fink, by his mother, Mrs. Joseph T. Pearson, and by a brother, Roderick G. Kellett.

News of Members

▸ **E. W. (Pop) Cleveland** (M.), Vice-President, Cleveland Pneumatic Tool Company, was honored at a dinner on August 10 in Cleveland. The occasion marks the 40th anniversary of Mr. Cleveland's first solo flight on August 18, 1911.

▸ **H. P. Folland** (F.) has resigned his position as Managing Director of Folland Aircraft, Ltd., England. However, Mr. Folland is continuing to serve on the Board of Directors of the company.

▸ **Myron B. Gordon** (A.F.), has been named Consultant to Laurance S. Rockefeller (A.M.). Mr. Gordon will work with Harper Woodward (A.M.), Counsel and Adviser on Aviation Matters to Mr. Rockefeller.

▸ **Eugene B. Jackson** (A.M.), Office of Aeronautical Intelligence, N.A.C.A., was recently elected Chairman, Science-Technology Division, Special Libraries Association. Shortly before that time, he was named Secretary, Group for Standardization of Information Services.

▸ **Eric Reissner** (A.F.), Professor of Mathematics, Massachusetts Institute of Technology, spent 5 weeks of the past summer as Consultant on Structures and Load Research at N.A.C.A.'s Langley Aeronautical Laboratory.

▸ **Norman L. Winter** (M.), Chief Sales Engineer, Sperry Gyroscope Company, Division of The Sperry Corporation, has been appointed as Chairman of the Navigation Technical Group, Research and Development Board, Department of Defense.

Members on the Move

The purpose of this section is to provide information concerning the latest affiliations of I.A.S. members. All members are, therefore, urged to notify the News Editor of changes as soon as they occur.

Luther J. Boyer (T.M.), Research Engineer, Rocket Section, Bell Aircraft Corporation. Formerly, Junior Project Leader, Flight Test, Chance Vought Aircraft Division, United Aircraft Corporation.

William H. Brearley, Jr. (M.), Engineering Products Department, RCA Victor Division, Radio Corporation of America. Formerly, Catapult and Launcher Project Engineer, Naval Aircraft Factory, Naval Air Material Center, Philadelphia, Pa.

Dr. Robert F. Brodsky (T.M.), Supervisor of the Aeronautical Division, Research Department, Sandia Corporation. Formerly, Staff Member, Research Department, Sandia.

Lieutenant Commander William Bryson, U.S.N. (A.M.), Public Information Officer, Staff, Commander, Air Forces Pacific Fleet, Naval Air Station, San Diego, Calif. Formerly, Public Information Officer, Bureau of Aeronautics, Department of the Navy, Washington, D.C.

George H. Buchner (M.), Manager, Spare Parts Administration, Customer Relations Division, Northrop Aircraft, Inc. Formerly, Manager, Contract and Order Department, Propeller Division, Curtiss-Wright Corporation.

W. Kenneth Bullivant (M.), Research and Development Engineer, Safe Flight Instrument Corporation. Formerly, Supervisor, Aerodynamics Section, Link Aviation, Inc.

Norman W. Carey (T.M.), Research Engineer, Mechanisms and Propulsion Section, Applied Mechanics Division, Armour Research Foundation, Illinois Institute of Technology. Formerly, Associate Engineer, Mechanisms and Propulsion Section, etc.

John Cobb Cooper (M.), now Director of the Institute of International Air Law and Professor of Law, McGill University, as well as Research in International Air Law, 240 Nassau Street, Princeton, N.J.

First Lieutenant Robert L. Dickinson, U.S.A.F. (T.M.), 7300 Materiel Control Group, A.P.O. 10, c/o Postmaster, New York, N.Y. Formerly, Student, University of Oklahoma.

K. R. Duee, Jr. (M.), Aeronautical Field Engineering Manager for Aircraft Hose Assemblies and Fittings, Resistoflex

ELECTED TO BRISTOL BOARD

Archibald Edward Russell (F.), Chief Designer, Aircraft Division, The Bristol Aeroplane Company, Ltd., was recently elected to the company's Board of Directors. Mr. Russell first joined Bristol 25 years ago in the Stress Office and was made its head 2 years later. He was appointed Chief Technician in 1932, Deputy Chief Designer (Aircraft) in 1937, and Chief Designer (Aircraft) in 1943. Mr. Russell, who is also a Fellow of the Royal Aeronautical Society, was the Wright Brothers Lecturer in December, 1949. His subject was "Some Factors Affecting Large Transport Aeroplanes with Turboprop Engines."

Corporation. Formerly, Aeronautical Sales and Service Manager, Instrument Division, Thomas A. Edison, Inc.

Captain Wendell P. Garton, U.S.M.C.R. (T.M.), S.M.S.-24, M.A.G.-24, Marine Corps Air Station, Cherry Point, N.C. Formerly, Student, Stanford University.

Raymond J. Goskowski (T.M.), Stress Analyst, Republic Aviation Corporation. Formerly, Junior Structural Test Engineer, The Glenn L. Martin Company.

Eli Grossman (T.M.), now Stress Analyst, Republic Aviation Corporation.

Raymond F. Halen (M.), Aircraft Sales Engineer, The Parker Appliance Company. Formerly, Sales Engineer, Hydro-Aire, Inc.

Captain John T. Hayward, U.S.N. (A.F.), Head, Research and Development for Military Application of Atomic Energy, Atomic Energy Commission. Formerly, with Composite Squadron Five, Naval Air Station, Norfolk, Va.

Theodore Himka (M.), Assistant Project Engineer, Wright Aeronautical Corporation, Curtiss-Wright Corporation. Formerly, Aerodynamicist, Sverdrup & Parcel, Inc.

Clarence S. Howell, Jr. (T.M.), Designer "B," Boeing Airplane Company. Formerly, Graduate Student and Candidate for Graduate Degree of Aeronautical Engineer, Massachusetts Institute of Technology.

Clyde W. Hull (A.M.), Assistant Manager of Manufacturing, Solar Aircraft Company. Formerly, Manager, New York Office, Solar.

Roger A. Johnson (T.M.), Design Engineer (Flight Controls), Aeronautical Division, Minneapolis-Honeywell Regulator Company. Formerly, Stress Analyst, Douglas Aircraft Company, Inc.

Dr. Donald H. Loughridge (A.F.), Assistant Director, Division of Reactor Development, Atomic Energy Commission. Formerly, Senior Scientific Adviser to the Secretary of the Army, Department of the Army, Washington, D.C.

Richard E. Martin (M.), Dynamics Engineer, San Diego Division, Consolidated Vultee Aircraft Corporation. Formerly, Graduate Student and Candidate for M.S. Degree in Aeronautical Engineering, University of Illinois.

Henry Moos (T.M.), now Aeronautical Design Engineer, Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation.

Alan Y. Pope (M.), Head, Experimental Section, Research Department, Sandia Corporation. Formerly, Associate Professor, Daniel Guggenheim School of Aeronautics, Georgia Institute of Technology.

Joseph W. Powers, Jr. (M.), Chief Engineer, Burton Electrical Engineering Company, El Segundo, Calif. Formerly, Research Engineer, El Segundo Plant, Douglas Aircraft Company, Inc.

Second Lieutenant Melvin Poznanski, U.S.A.F. (T.M.), now 3401 Stu. Sq. (0), Keesler Air Force Base, Miss.

First Lieutenant Robert M. Rivello, U.S.A.F. (T.M.), Research Engineer, Applied Mechanics Group, Flight Research Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. Formerly, Assistant Professor, Aeronautical Engineering Department, University of Maryland.

Edward E. Roberts (M.), Design Specialist, Ryan Aeronautical Company. Formerly, Weights Group Engineer, Consolidated Vultee Aircraft Corporation.

Robert F. Robinson (T.M.), Assistant Professor, Department of Aeronautical Engineering, U.S. Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio. Formerly, Instructor, The School of Aeronautics, Purdue University.

William A. Sangster (M.), now with Structures Department, Instituto Tecnológico de Aeronáutica, São Jose dos Campos, São Paulo, Brazil.

George Schairer (A.F.), Chief of Technical Staff, Boeing Airplane Company. Formerly, Staff Engineer, Aerodynamics and Power Plant, Boeing.

Captain Franklin C. Spinney, U.S.A.F. (M.), Chief, Personal Equipment and Uniform Branch, Directorate of Operations, Headquarters, Air Research and Development Command. Formerly, Chief, Rescue Unit Equipment Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio.

Dr. Theodore K. Steele (M.), Research Engineer, Bulova Research and Development Laboratories, Inc. Formerly, Instructor of Mechanical Engineering and

(Continued on page 40)

PROMOTED BY SPERRY DIVISION

Duncan B. Gardiner (M.) has been appointed to the position of Assistant Chief Engineer, Vickers Incorporated, Division of The Sperry Corporation. Mr. Gardiner has been Chief Product Development Engineer since 1944. Prior to this time, he served as a Product Engineer in Vicker's Navy, Industrial, and Aircraft Divisions for a total of 16 years.

N.A.D.C. COMMANDER PROMOTED

Rear Adm. Selden Booth Spangler, U.S.N. (F.), Commander, U.S. Naval Air Development Center, Johnsville, Pa., was recently promoted to that rank. A Navy pilot and aeronautical engineer, 11 of his 32 years in the Navy have been spent with the Bureau of Aeronautics' Power Plant Division. Appointed head of this Division in 1939, he was assigned during the next 6 years to special duties in connection with aircraft engine research and development that included service with the following: Jet Propulsion Committee, Allied Nations; Jet Propulsion Committee, N.A.C.A.; Aircraft Power Plant Committee, N.A.C.A.; and Head, Naval Air Technical Mission to Japan in 1945. Admiral Spangler authored the Guest Editorial on "Electronics in Aviation" which was published in the May, 1951, issue of the REVIEW.

American Helicopter Society News

July Dinner Meeting of Mid-Eastern Region

Approximately 140 members and guests of the American Helicopter Society and Institute of the Aeronautical Sciences were present at the Mid-Eastern Region dinner meeting held on July 19 at the Penn-Sheraton Hotel in Philadelphia.

T. R. (Ren) Pierpoint, Piasecki Helicopter Corporation's Service Manager and Vice-President of the A.H.S. Mid-Eastern Region, chairmanned the meeting. The guest speaker was Lt. Comdr. John Armstrong, formerly Engineering Officer, Helicopter Squadron HU-2, Lakehurst Naval Air Station, and more recently, Project Officer on the Class Desk, Bureau of Aeronautics, Department of the Navy. Commander Armstrong spoke on the "Maintenance Problems of Naval Helicopter Operations," drawing from his experience with COMAIRLANT while on duty with HU-2.

Commander Armstrong pointed out that there are two primary factors leading to maintenance problems. First is personnel. In this regard, service pilots have a small amount of experience, and techniques have not been finally resolved. Also, there are not enough trained mechanics, and the tremendous expansion of the industry has brought about a dire need for thoroughly trained and experienced men. In addition, fleet operational personnel are just now in the process of becoming sufficiently familiar with the helicopter to exercise due consideration in giving out orders for helicopters to fulfill.

In regard to general maintenance problems, Commander Armstrong discussed twelve salient deficiencies. The first problem, he stated, was lack of spare parts and the fact that concurrency must be maintained. The second problem—the use of nonstandard AN parts in "off-the-shelf" helicopters—is partially being solved with the production helicopter, but an adequate solution is needed. The third—a definite lack of technical literature on newly procured helicopters—means more erection and maintenance handbooks, pilot's handbooks, illustrated parts lists, and similar publications.

As a fourth point, Commander Armstrong pointed out poor accessibility for maintenance and inspection as another problem for maintenance men. In this regard, some improvement has been noticed in later aircraft, but it is a factor that should be given all possible consideration.

Fifth—generally speaking, weight-saving efforts have been carried too far, with the result that the helicopters are comparatively fragile. The squadron would prefer 10 per cent less pay load if it could get a 20 to 30 per cent increase in availability. Sixth—transmissions, hubs, blades, etc., require overhaul replacement too often. The speaker pointed out it is his belief that all components should be capable of operating for at least 1,000 hours between inspections to give optimum operational efficiency.

Seventh—A special Navy problem has been difficulty in ground and deck handling. Also, salt-water corrosion has caused an excessive amount of maintenance. The manufacturer should do all that is possible to overcome this problem by design and metallurgical improvement.

Eighth—new helicopters have been placed in extensive service operations before complete evaluations could take place. Commander Armstrong strongly requested helicopter manufacturers to follow closely the early field operations of their helicopters in order to correct deficiencies in the early stages of flight operations. Ninth—many electronic difficulties have been experienced as a result of excessive vibration and poor antenna locations. The contractors should do everything possible to simplify maintenance on electronic equipment. Tenth—Commander Armstrong stated that he would like to see an engine or series of engines designed specially for helicopters. He pointed out that all present-day helicopters use fixed-wing engines and operate them continuously much too near the take-off ratings and at high speed. This results in increased operational malfunctions and maintenance.

Lieutenant Commander John Armstrong, U.S.N., Project Officer on Class Desk, Bureau of Aeronautics, Department of the Navy.

The speaker further advocated the design of kits to permit helicopters to be operated in extreme climatic zones. These kits would provide specialized, interchangeable parts that could be easily installed. In addition, they would provide the 'copter with proper equipment to carry out specialized missions such as photographic and geodetic survey, beach mustering, etc., in a minimum of time. Interchangeability of parts has proved a problem, particularly in the early helicopters. Later 'copters have improved in this respect, although, Commander Armstrong pointed out, all efforts must continue to be put forth to make all components completely interchangeable.

Commander Armstrong concluded that the helicopter has proved it can be readily operated in service with skilled maintenance and operational personnel. However, he again emphasized that all manufacturers should attempt to learn as much as possible about the product in the field, so that continual improvement and ease of operations will result.

Copies of the complete text of Commander Armstrong's talk are being duplicated for distribution to all members of the A.H.S.

Other guests and officers of the A.H.S., introduced by the Chairman and reporting to the group were: Chuck LeFever, of Prewitt Aircraft Company who, as Proceedings Chairman of the recent Helicopter Forum, reported that the papers presented at the Forum would be available within a short time through the Institute of the Aeronautical Sciences; Comdr. J. W. Klopp, Bureau of Aeronautics Representative at Morton, Pa.: Tom Harriman, Bell Aircraft Corporation, A.H.S. Membership Chairman; Monroe Brown, A.H.S. Treasurer; Capt. J. R. Poppen, U.S.N. of Aviation Acceleration Laboratory, Johnsville, Pa., who spoke briefly on G-force research; Steve Tremper, Piasecki Helicopter Corporation, who, as the 1952 A.H.S. Forum Chairman, reported that the next Forum will be held in Washington; and Lt. Col. Douglas Rundquist, U.S.A.F., Head, Air Force Procurement Office in Philadelphia, who offered that office's assistance to all prime contractors and subcontractors present in the selling and purchasing of subcontract work.

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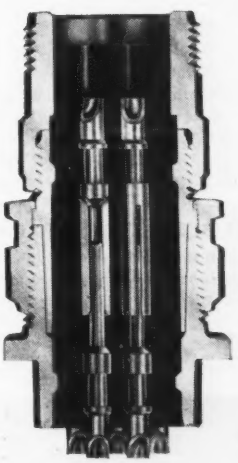

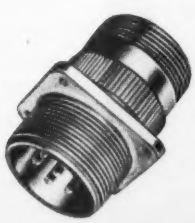

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News of Members

(*Continued from page 37*)

Candidate for Doctor of Engineering Degree, New York University.

John R. Stiles (M.), Project Engineering Division, Rohr Aircraft Corporation. Formerly, President, John R. Stiles & Associates, Industrial Consultants, Ridley Park, Pa.

Captain James P. Sturrock, U.S.A.F. (M.), Aerodynamics Group, Flight Research Laboratory, Research Division, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. Formerly, Aerodynamics Engineer, Convair Ordnance Aerophysics Laboratory, Daingerfield, Tex.

Armand J. Thieblot (A.F.), President, Armand J. Thieblot Aircraft Engineering Company, 1005 E Street, N.W., and 502 Kennedy St., N.W., Washington, D.C. Formerly, Chief Engineer, Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation.

R. J. B. Woodhams (M.), Assistant Chief Designer (Aircraft Division), Air Service Training, Ltd., England. Formerly, Chief of Projects, A. V. Roe & Company Ltd., England.

Robert H. Wright (T.M.), Tool Engineer, Day & Zimmermann, Inc., Lone Star Ordnance Plant, Texarkana, Tex. Formerly, Tool and Machinery Design Engineer, Ordnance Department, Iowa Ordnance Plant.

Richard Yoder (T.M.), now Junior Engineer, Boeing Airplane Company.

Corporate Member News

• **Aeroproducts Division, General Motors Corporation** . . . A resident Aeroproducts Branch Office of the Dayton Regional Office, Central Air Procurement District, Air Materiel Command, U.S.A.F., has been opened with a personnel staff of 22.

• **Allis-Chalmers Manufacturing Company** . . . J. L. Singleton, Vice-President in charge of the General Machinery Division, and R. S. Stevenson, Vice-President in charge of the Tractor Division, have been elected to the company's Board of Directors. W. E. Hawkinson, who has been Secretary and Treasurer of Allis-Chalmers, was named a Vice-President, Secretary, and Treasurer of the company . . . William C. Johnson, Executive Vice-President and Director of Allis-Chalmers, died suddenly on July 26 at the age of 49. He had been with the firm since 1924 and an officer of the company since 1944.

• **Aluminum Company of America** . . . The first aluminum smelting plant to use lignite for fuel is scheduled to be constructed at one of several alternate locations approximately 60 miles south of Waco, Tex. The electricity required by the new plant, which will have a production capacity of 85,000 tons of aluminum annually when completed, will be generated by the steam-driven equipment using processed lignite as fuel.

• **American Airlines System** . . . Miss Carlene Roberts was recently elected to the post of a Vice-President of the company. She will remain in charge of American's Washington, D.C., administrative office. Miss Roberts had previously been an Assistant Vice-President since 1945, serving during that time as head of the Washington office.

• **Boeing Airplane Company** . . . The first production model of the 72-ton KC-97E Stratofreighter was delivered on July 18 to the U.S. Air Force. The KC-97E, the ninth model in the double-deck Stratofreighter series, is designed to operate as a tanker aircraft, troop transport, cargo carrier, or hospital airplane. It can be converted within a few hours from one use to any of the other uses for which it is designed . . . A B-47 bomber was fitted out with special equipment to measure and record atomic blast data during last summer's Eniwetok Proving Ground tests. The work was accomplished by the Wichita Division.

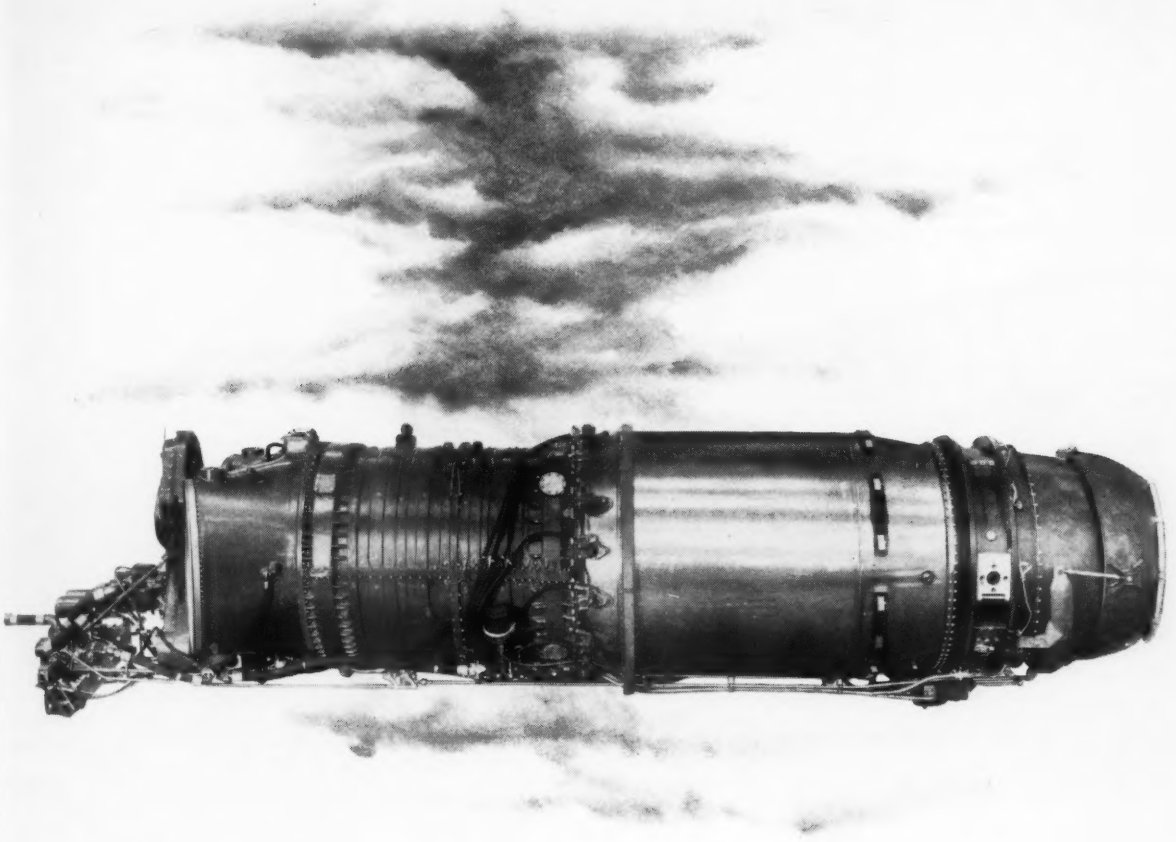
• **Brown Instruments Division, Minneapolis-Honeywell Regulator Company** . . . A functionally designed flow meter that incorporates, among other things, an evenly graduated meter scale and electronic integration has been developed. Said to give fast and accurate response over an entire range and to feature low initial cost and maintenance, this differential type meter is supplied in three ranges—i.e., 53, 119.25, and 212 in. of water, and for 750 and 1,500 lbs. per sq.in. of static pressure. For dry calibration, the three ranges are slightly greater . . . The first semester courses in industrial instrument maintenance and repair were begun on September 17 at the Brown School of Instrumentation, Philadelphia, for the benefit of customer and Brown personnel. These courses and those of the second semester which begin in January, include a 13-week comprehensive course concurrent with the shorter classes.

• **Canadair Limited** . . . The twin-engine T-36, which although basically an advanced trainer is readily convertible to a cargo transport, will be produced at Canadair's Plant No. 1 in addition to Beech Aircraft Corporation's facilities at Wichita, Kan. Canadair and Beech will cooperate in the engineering design of the aircraft and in the design and fabrication of many of the tooling items. Canadair is scheduled to produce an unspecified number of the T-36's for the Royal Canadian Air Force as well as those contracted for by the U.S. Air Force.

• **Consolidated Vultee Aircraft Corporation** . . . The construction of a U.S. Navy-owned and Convair-operated facility was begun this last August in Pomona, Calif. It will take approximately one year to complete. When completed, this new plant, with an aggregated floor area of more than 1,200,000 sq.ft., will be occupied by the Guided Missile Division for the manufacture of supersonic interceptor-type missiles for the Navy's Bureau of Ordnance. The two-stage antiaircraft rocket "Terrier," which is still on the classified list, is said to be the first project

SUPER CONSTELLATION MAKES FIRST FLIGHT

Shown in a first-flight photo is the new Super Constellation that is now in quantity production at Lockheed Aircraft Corporation and is scheduled to begin flying with the air lines this year. This new $1,500,000 transport is designed for ultimate conversion to jet power plants. Its fuselage is 18 ft., 5 in. longer than the companion Constellation, thus giving the Super Constellation an overall length of 113 ft., 7 in. By enlarging the main cabin area from 561 to 744 sq.ft., the passenger capacity has been increased by an average of 35 per cent.



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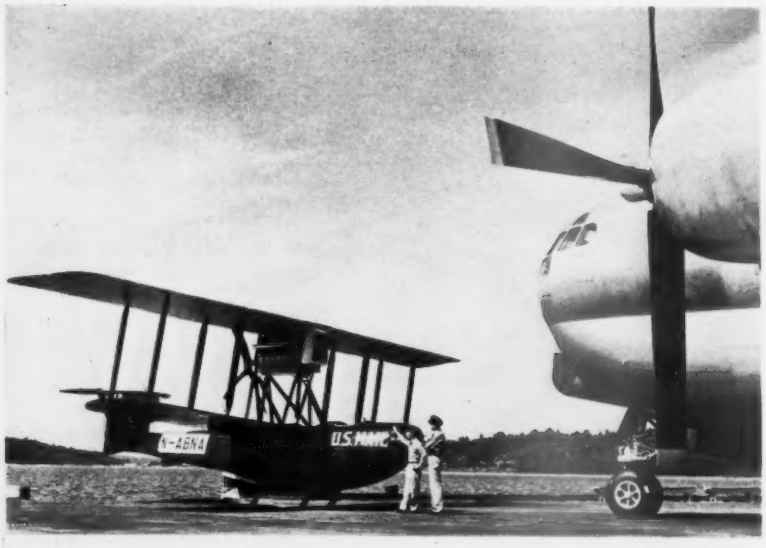


THE OLD AND THE NEW AT BOEING

As the Boeing Airplane Company celebrated the 35th anniversary of its founding on July 15, 1916, the first aircraft to be designed entirely by Boeing engineers (the first venture by the company into the commercial aviation field) was being readied to take her place as one of the chief exhibits in the Seattle Historical Society's new Museum of History and Industry. The airplane in question is the Boeing B-1 flying boat (left). This 32-year-old boat with a 50-ft., 3 1/8-in. wing span was built of laminated red cedar and developed, using a Hall-Scott Liberty-6 engine, a top speed of 93 m.p.h. C. L. Egtvedt, I.A.S. Fellow and Founder Member, Boeing's Chairman of the Board, was then Chief Engineer on the B-1's design. Nosing into the picture with the old B-1 is one of her more recent descendants, the Boeing C-97 Stratofreighter, which weighs in at more than 72 tons and cruises at over 350 m.p.h.

scheduled for production . . . The all-jet swept-wing version of the B-36 bomber has been designated the YB-60. It will be powered with eight turbojet engines. The first two models are being built at the Fort Worth Division . . . A newly constructed $270,000 test stand, in which four jet engines can be tested simultaneously, is nearly ready for use at the Fort Worth Division.

• **Cornell Aeronautical Laboratory Inc.** . . . Much of the credit for the development of modern-day air-inflated radomes goes to Cornell Aero Lab. A study aimed at exploring the idea of this type of radome was instituted by the Laboratory's Development Division under an Air Force contract (Watson Laboratories). After the successful completion of work relative to load-carrying abilities, high-wind resistances, low-temperature properties, and de-icing studies of various models, the building and testing of full-scale radomes was carried on under a subcontract with General Electric Company. Since the U.S. Air Force acceptance of these radomes, they have been manufactured by The Firestone Tire and Rubber Company, The B. F. Goodrich Company, and others for use by the Air Force primarily to house aircraft warning equipment installed in the more frigid parts of the earth. A design manual, giving the principles and detailed information of the design and construction of these radomes, has been compiled by Cornell Aero Lab. . . . The six laboratory executives who have been elected corporate officers are: William M. Duke, A.F.I.A.S., Vice-President, Technical Operations; Henry K. Moffitt, Vice-President, Business; John E. Gallagher, Treasurer; John J. O'Neil, Secretary; Ray H. Puffer, Assistant Secretary; and Lloyd R. Everingham, Assistant Secretary. Elected to the Board of Directors was John Carlton Ward, Jr., M.I.A.S., formerly Chairman of the Board, Fairchild Engine and Airplane Corporation.

• **Curtiss-Wright Corporation** . . . A new group to be known as the Metal Processing Division will be established in the former Buffalo (N.Y.) Stainless Castings Company plant where newly developed methods will be applied to make essential materials and products of various kinds for aircraft uses. This sixth operating division of Curtiss-Wright will, it is said, have a sufficiently versatile capacity to supply vital parts for a wide range of aircraft engines . . . Thomas C. Coyne has been elected to the position of Vice-President in charge of Scheduling, Planning, and Production Control. Mr. Coyne was formerly Director of Programming and Planning, Ford Motor Company.

• **Douglas Aircraft Company, Inc.** . . . A new electronics building is to be constructed at Tulsa, Okla., under an Air Force construction contract. This facility will be used in connection with the inspection and final check-out of the B-47, which will be built by Douglas at the Oklahoma plant . . . According to schedule, the production of two new guided missiles is due to move into the new Santa Monica plant this month. One of these two guided missiles is a ground-to-air antiaircraft supersonic missile for Army Ordnance; the other one is an air-to-air missile for the Navy.

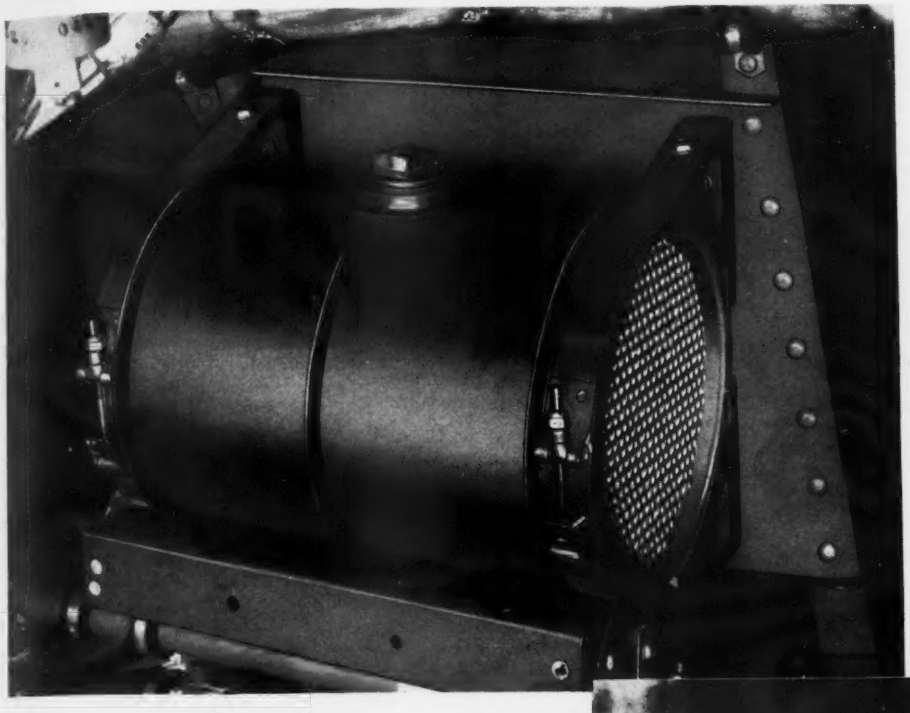
• **Eastern Air Lines, Inc.** . . . Final orders in a $100,000,000 re-equipment program, initiated about 2 years ago, were signed last July by Eastern's President and General Manager, Capt. Eddie Rickenbacker. This program includes procurement orders to Lockheed Aircraft Corporation and to The Glenn L. Martin Company for a total of 90 new transports that can be converted "overnight" to turbojet power plants as soon as that type engine is released by the military for commercial use. One-third of this new fleet will be the 88-passenger Lockheed Super-Constellations; the remaining two-thirds will consist of the 40-passenger Martin 4-0-4 transports. This new operating fleet will be used to replace everything now in Eastern's service with the exception of 20 New-Type Constellations. The $100,000,000 re-equipment program also involves a $5,000,000 provision for new equipment and servicing facilities, including the world's largest commercial overhaul and line maintenance building on which construction will begin shortly at Eastern's main operating base in Miami, Fla. Additional operating facilities are also scheduled for New York, Chicago, and Atlanta, Ga. . . . A 60-page illustrated analytical report on the operations and position of Eastern has been prepared by Selig Altschul, Aviation Advisory Service, as an independent study. It is being distributed by Smith, Barney & Company, New York investment brokers.

• **Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation** . . . Construction has been started on a revised model of the Flying Boxcar. This new model, to be known as the C-119H, is scheduled to be ready for its first flight early in 1952. The C-119H will incorporate, among other changes, an increase in the wing area.

• **The B. F. Goodrich Company** . . . An Inflatable Strip Seal has been developed to prevent high-altitude blowouts in military aircraft. Made of a special rubber-coated textile fabric, it is said to be easily inflated or deflated. Sealing requires only a few pounds of pressure above that inside the canopy. Designs of the seal vary with each airplane model and type. This new product may also be utilized as weather seals between fuselages and detachable cargo structures of transport aircraft and as water seals in amphibious planes.

• **General Electric Company** . . . A new 24-page booklet entitled *Electric Power for Industry's Third and Biggest Expansion* is now available. Designated as bulletin GEA-5600, this publication is illustrated with 52 photographs and diagrams. It outlines methods of obtaining electric power equipment for quick expansion at low cost and with a minimum of critical materials.

• **Industrial Sound Control and A. V. Roe Canada Limited** . . . New and elaborate suppression equipment recently installed in Avro Canada's jet-engine test houses has reduced the effect of the jet-engine sounds on the human ear to one-fiftieth, so that it is now possible to converse normally within 5 ft. of the engine. This sound-proofing equipment was designed,



DEATH TO ENEMY SUBMARINES. Martin anti-submarine seaplanes feature a new type of hull in which the keel is under water from nose to tail. Equipment includes latest electronic submarine detection devices plus armament for destroying undersea raiders. They carry Clifford Feather Weight All-Aluminum Oil Coolers.

Clifford Feather Weights Cool the Oil in MARTIN P5M-1 MARLINS

All types of modern aircraft — including jet powered — depend on Clifford Feather Weight All-Aluminum Oil Coolers. *The only all-brazed type of oil cooler*, they owe their superior weight-strength ratio to Clifford's patented brazing method and pre-testing. This pre-testing takes place in Clifford's wind tunnel laboratory, the largest and most modern in the aeronautical heat exchanger industry. For complete details, write Clifford Manufacturing Company, 138 Grove Street, Waltham 54, Mass. *Division of Standard-Thomson Corporation*. Sales offices in New York 17, Detroit, Chicago 1, Los Angeles.

CLIFFORD

HYDRON Metal Bellows

ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES

HYDRAULICALLY-FORMED BELLOWS AND BELLOWS ASSEMBLIES

manufactured, and installed by Industrial Sound Control in cooperation with Avro Canada engineers.

• **Jack & Heintz, Inc.** . . . A new aircraft electrical control system, featuring lightness, compactness, and ease of maintenance, is made up of a main-line contactor, a voltage regulator, and various types of relays. All components, except the main-line contactor and current relay, are mounted on a quickly removable, plug-in control panel that fits any standard radio rack and is interchangeable between the B-47B and B-47C military aircraft. Units are made up on order for any military or commercial planes . . . A new 9.5-hp. d.c. fuel booster-pump motor, model DA15, said to be an integral part of the Boeing "flying boom" system of in-flight refueling, was designed by Jack & Heintz engineers with an eye not only toward the actual driving of the booster pump but also toward its safe operation in the highly explosive atmosphere of high-octane gasoline. Flame arrestors placed at the air-inlet and air-outlet ventilating ducts of the motor are designed to nullify any serious effects of an explosion and to confine the resulting flame to that area while the explosive force (minus flame) is dissipated harmlessly through the arrestors and ducts

• **Lear, Incorporated** . . . Many "unnecessary and irksome mental operations" that are usually inherent to the ultimate solution in flight of any propounded navigational problem are said to be eliminated by the recently developed Learmatic Navigator. This instrument combines the functions of the magnetic and the radio compass (or automatic omni) indications and presents simultaneously a graphic representation of the magnetic heading of the aircraft being flown, of the course to be remembered, and of the direction toward the radio station tuned in on the radio compass. A two- or three-way selector switch may be added to connect its Indicator-Synchro-type radio unit to either the No. 1 radio compass (red pointer), the No. 2 radio compass (green pointer), or the automatic omni repeater circuit.

• **Lockheed Aircraft Corporation** . . . The concentration of corrosive exhaust gases from the jet stacks of the Constellations have caused a wide band of automotive-type enamel to be painted longitudinally on the underside of the wings aft of each engine. The purpose of these painted bands of various colors is to protect the metal and to hide underwing smudge . . . The early P2V-4's have been returned to the factory by the Navy in order to have the originally installed power plant exchanged for the Wright Turbo Cyclone engine.

• **The Glenn L. Martin Company** . . . The first production model of Martin's newest commercial transport, the 4-0-4, made its initial flight on July 27. This aircraft, which is convertible to jet power plants, was test flown completely equipped, including the pressurization system. This particular ship is destined to be delivered to Trans World Airlines and is one of 41 air liners on order by T.W.A. . . . James Allen has been elected a member of the Board of Directors.

• **Minneapolis-Honeywell Regulator Company** . . . A new plant for use by the Aeronautical Engineering Division in developing and producing electronic devices to benefit the jet pilot was dedicated on July 11 in Minneapolis.

• **North American Aviation, Inc.** . . . The North American F-86 Sabre and Boeing KB-29F tanker successfully carried out air-to-air refueling in test runs. The F-86 is the second North American airplane to complete in-flight refueling tests. The first one was the RB-45C Tornado.

• **Pan American World Airways, Inc.** . . . Russell B. Adams, who was serving as Special Assistant to the Secretary of State, has been elected a Vice-President of the company. Headquartered in Washington, D.C., he represents Pan American in Government matters.

A DEMON FLIES

The XF3H-1 Demon, built by McDonnell Aircraft Corporation, completed its first flight on August 7, remaining aloft for 24 min. This Navy fighter is powered by a Westinghouse jet engine and is the company's first new experimental Navy fighter to fly since the experimental Banshee made its initial flight in January, 1947. Like the Banshee and the Phantom, the name of this current plane, Demon, is derived from the spirit world.

• **The Parker Appliance Company** . . . A reformulation of synthetic rubber O-ring Compound 41 has extended its temperature service range considerably. Formerly rated for the −65° to +165°F. temperature range, it can now withstand temperatures up to 300°F. without any loss in flexibility characteristics at −65°F. The formulation is resistant to aircraft engine oils AN-VVO-446 grade 1120, AN-O-8, S.A.E. 40, 50, 60 oils, and similar fluids. Other properties of Compound 41 include: shore A hardness of 65°, elongation of 350 per cent, and tensile strength of 2,135 lbs. per sq.in.

• **Pesco Products Division, Borg-Warner Corporation** . . . Robert D. Turner, who has been Assistant to the Treasurer, Pesco Products, has been appointed Secretary-Treasurer, Marvell-Schebler Products Division, Borg-Warner.

• **Pratt & Whitney Aircraft Division, United Aircraft Corporation** . . . The program for converting air-line-operated R-4360 TB3G Boeing Stratocruiser engines to the B6 and later to the CB2 series engines is scheduled to get under way early in 1952 with the delivery of the initial sets of conversion kits. This conversion program will cost the company an estimated $10,000,000 in spare engine parts. Actual conversion will be handled by the operators during their regular engine overhaul work, with the air lines standing the man power costs.

• **Republic Aviation Corporation** . . . A new $1,500,000 construction program at the Farmingdale, L.I., plant has been announced. The program consists of roofing-in and building-up of a 40,000 sq.ft. area between the parts plant and tool shop wings; the construction of a static test laboratory; and the modification of a hangar to accommodate foundry equipment. This construction is scheduled for completion by January, 1952 . . . Under the terms of a leasing agreement, a building now under construction on Cuba Hill Road, Greenlawn, L.I., N.Y., will be taken over by Republic, if the structure is satisfactorily completed by the owners for occupancy by November. Jet fighter parts will be produced in 46,000 sq.ft. of the factory area.

• **Sperry Gyroscope Company, Division of The Sperry Corporation** . . . A $30,000,000 guided missile plant near Bristol, Tenn., will be U.S. Navy-owned and Sperry-operated.

• **Standard Oil Company of California** . . . A new nondeposit-forming oil is scheduled to be placed on the market shortly. Results achieved thus far under extensive flight testing in all types of regular service conditions are said to be outstanding.

• **Standard Oil Company (Indiana)** . . . A plan has been announced whereby some $190,000,000 will be expended this year on an extensive expansion program that will enable the company to meet increased civilian, industrial, and military demand for petroleum products. This expansion is expected to yield not only larger quantities of aviation and high-quality motor gasoline, but also an increase in the crude running capacity of the refineries. Standard Oil (Indiana) is currently increasing its commercial activities in the field of

Higher...faster!
Let enemy planes approach at supersonic speeds and high altitudes — this new Navy jet interceptor will stop them! It's the Douglas XF4D Skyray. Now flying, the XF4D is a bat wing airplane of advanced design. The Skyray is designed for catapult take-off from carriers to intercept an enemy before he can attack us on land or sea. The Skyray was designed and built by Douglas at the El Segundo Division. It is another of the advance-type combat planes with jet, rocket and turbo-prop propulsion that reflect the pioneering of Douglas engineers in the many fields of aeronautical science. Douglas Aircraft Company, Inc.
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WORLD'S LARGEST BUILDER OF AIRCRAFT FOR 30 YEARS
MILITARY AND COMMERCIAL TRANSPORTS
FIGHTERS • ATTACK PLANES • BOMBERS • GUIDED MISSILES
ELECTRONIC EQUIPMENT • RESEARCH

chemicals from petroleum based on intensive research in the past few years.

• **United Air Lines, Inc.** . . . A mobile electric power unit that has a maximum output of 2,500 amps., including an overload value of 500 amps., was recently placed into service at Honolulu, T.H. The unit is used to operate the air-cooling system of Mainliner Stratocruisers and thus to maintain comfortable cabin temperatures while the aircraft are on the ground loading passengers. The unit was built to United's specifications by the Hobart Manufacturing Company.

• **Westinghouse Electric Corporation** . . . A high-intensity runway light (Type US) directs its two main beams of light up and down the runway; its one-piece 360° glass lens provides "off-runway" light for circling guidance. This bidirectional light is available with clear, clear-yellow, or green lenses for runway and threshold markings. The light uses a 200-watt, 6.6 amp., T-14 bulb, prefocus-base aviation lamp.

• **Wright Aeronautical Corporation, Curtiss-Wright Corporation** . . . Stanley B. Kurzina, Jr., has been named Vice-President in charge of Operations. Mr. Kurzina has been with Curtiss-Wright since October, 1949, as Director of Manufacturing Engineering.

Meet Your Section Chairman

C. E. Pappas

New York Section

Costas Ernest Pappas is originally from Providence, R.I., having been born there on October 14, 1910. He attended the Newtown High School in Elmhurst, L.I., N.Y., and when the time came to matriculate at a college, he selected New York University. He was graduated from there in 1933 with a Bachelor of Science degree in Mechanical Engineering with an Aeronautical Option and the following year was granted a Master of Science degree in Aeronautics. While completing the prerequisites for his Master's, he "doubled in brass" as a Laboratory Assistant in Hydraulics and Structures at the University.

Mr. Pappas has been with Republic Aviation Corporation for about 16 years, having first joined the predecessor company, Seversky Aircraft Corporation, in 1935 as a Stress Analyst. For 3 years or more, he was assigned to the Stress Analysis Department and was in a large measure responsible for the performance computations made during that period. About 1938, he was transferred to Aerodynamics and Preliminary Design work; 2 years later, he was promoted to Chief of Aerodynamics, a position he holds today. As head of this group, he is and has been in charge of the aerodynamic development of Republic prototypes.

Mr. Pappas is considered an authority in aerodynamics, especially in the field of compressibility. Achieving this status in this particular phase was not just a quirk of fate; conversely, it was a planned maneuver. Physics and mathematics have always been his "meat" since his precollege days. In deciding upon a likely career, he looked for that profession in which his love of both physics and mathematics could best be served. He found his answer in aircraft structures and aerodynamics, a decision, he tells us, he has never had cause to regret.

A man with 5 hours of solo flying time as a student pilot, Mr. Pappas counts among his off-time recreational activities the making of various types of furniture for his home. He and his wife, Thetis, have a small machine shop in the basement of their home where they turn out all kinds of things for their two youngsters, Alceste, aged 6, and Conrad, aged 3.

Mr. Pappas, who was awarded the Wright Brothers Medal for 1943 by the Society of Automotive Engineers of which he is a member, currently belongs to the N.A.C.A. Subcommittee on High Speed Aerodynamics. In 1948, he was appointed to the N.A.C.A. Special Subcommittee on Research Problems of Transonic Aircraft Design.

I.A.S. Sections

Detroit Section

F. A. Hiersch, *Chairman*

The following men were elected to office for the 1951–1952 year: F. A. Hiersch; Vice-Chairman, John Luecht; Treasurer, George Martin; and Secretary, Kenneth Smith.

Texas Section

R. Christy, *Secretary*

Members and guests of the Texas Section held a dinner meeting at the Blackstone Hotel, Fort Worth, on June 30. Ed Kurzawa, Chairman, opened the meeting and introduced the guest speaker, Group Capt. Christopher Clarkson, A.F.C., A.F.R.Ae.S., A.F.I.A.S., Civil Air Attaché, British Embassy. The subject of Mr. Clarkson's talk was "British Aviation Development." He discussed primarily the development of civil aircraft and pointed out that, in many cases, certain ideas or concepts that appeared to be unworkable at one time may prove to be the answer at some later date. Unlike military aircraft, which must be designed for high performance and built at all cost, civil aircraft must be designed for safety, comfort, and economy. Since it is the flying public that paves the way, it is necessary that civil aircraft be comfortable and maintain their flight schedules. The general public flies by daylight, whereas the business man usually flies at night.

Contrary to common belief, the de Havilland Comet was not subsidized by the British government. The government did, however, procure some of the aircraft built to the de Havilland specification.

Slides were shown of the various British civil aircraft and the speaker described the particular features of each. At the conclusion of his talk, films were shown of the Society of British Aircraft Constructors' displays of 1949 and 1950.

Student Branches

University of Alabama

The Student Lecture Award Contest was held on May 15. Norman L. Turnbull won the first prize for his lecture on "A Short History of Jet Propulsion." William O. Armstrong took second place in the contest. Chairman Mortimer D. Marks presided; 25 persons were present.

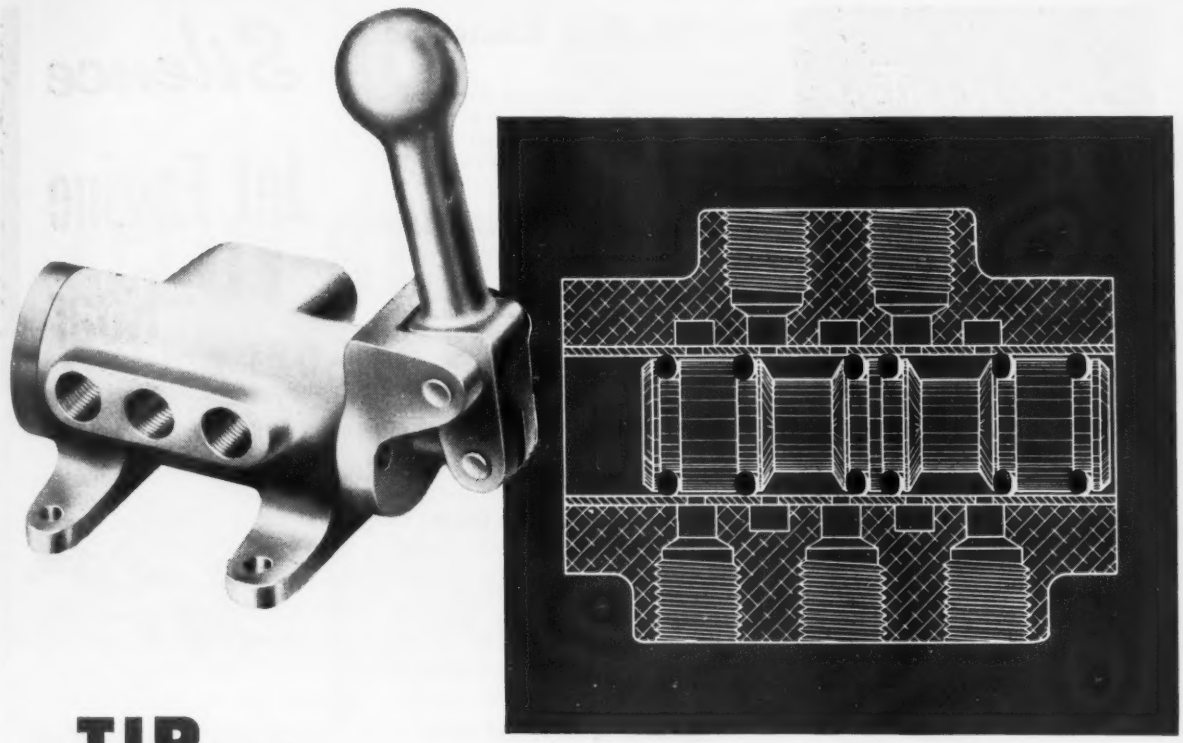
University of Kansas

Mechanical and electrical engineering students were the guests of the Department of Aeronautical Engineering on May 24 to hear Leroy Griffith, Chief Engineer, Measurement Section, Aeronautical Division, Minneapolis-Honeywell Regulator Company, speak on "Control Engineering." The attendance was 44. The address was followed by an election of officers with these results: Chairman, E. C. Linthicum; Vice-Chairman, Robert Miller; Secretary, Richard Etherington. Retiring Chairman Verle VanCamp presided.

On July 18, a Westinghouse film, *Banshee*, was shown. Chairman E. C. Linthicum presided; 22 persons attended.

New York University

At the last meeting of the 1950–1951 academic year, the following officers were elected: Chairman, Donald Mandell; Vice-Chairman, William C. Zeltner; Treasurer, Nicholas G. Vretakis and Secretary, Stanley Youth.



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Motion is controlled *positively* by adjustable mechanical limit stops. The adjustable load-sensitive limit switches are de-energized whenever the actuator either reaches the limits of mechanical travel or encounters the maximum permissible load. This construction provides two essential characteristics for dependable operation of valves, dampers, etc., up to 50 inch-pounds maximum operating load:

1. Accurate positioning of the driven device
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See condensed literature in 1951 I.A.S. Aeronautical Engineering Catalog or write for Bulletin 118.

ROTORette

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Lockheed F-94C

Republic F-84E, F-84F

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Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Hayward, John T., Captain, U.S.N., Head of Research & Development, Military Applications of Atomic Energy, A.E.C. (Washington, D.C.).

Pearson, Chester C., A.E., President & Gen. Mgr., The Glenn L. Martin Co.

White, George, B.S. in A.E., Aero. Engineer (Assistant Group Leader), N.A.C.A., Langley Air Force Base.

Elected to MEMBER Grade

Hermann, Rudolf, Ph.D , Dr. Habil.; Prof. of Aerodynamics, Dept. of Aero Engineering, University of Minnesota.

Muench, Albert, Dipl. Ing., Airworthiness Expert, Air Navigation Bureau, International Civil Aviation Organization (Montreal).

Transferred to MEMBER Grade

Tan, Hao Sung, Ph.D., Research Associate in Aerodynamics, Graduate School of Aero. Engineering, Cornell University.

Elected to Technical Member Grade

Belisle, Roland, Loftsman, Canadair, Ltd.

Para, Frank R., B.S.Ae.E., Engineer, The Globe Corp., Aircraft Div.

Transferred to Technical Member Grade

Ackerman, Arthur C., B.S.

Andersen, Arnold K., B.S., Technical Writer "A," Douglas Aircraft Co., Inc. (El Segundo).

Anderson, Harris E., B.S., Corp. & Aircraft Mechanic, Troop Carrier Wing, U.S.A.F.

Anderson, John J., Capt. & Advanced Engineering Management Student, U.S.A.F., Wright-Patterson Air Force Base.

Babcock, Roger M., B.S. in M.E., Jr. Analytical Engineer, Data Analysis—Jet Engine, Pratt & Whitney Aircraft Div., United Aircraft Corp.

Barnes, William H., B.E. in Ae.E., Captain, U.S.A.F.; Project Engineer, Structural Flight Loads, Wright-Patterson Air Force Base.

Baxter, William D., 1st Lt. & Pilot, U.S.A.F.

Beane, Beverly, M.S., Analytical Engineer in Aerodynamics Research, Massachusetts Institute of Technology.

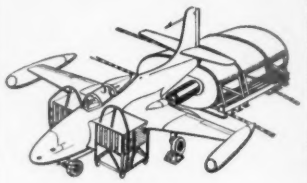
Beckman, Kenneth N., M.A.E., Major, Design & Development Officer (Guided Missiles), U.S.A.F., Holloman Air Force Base.

Bijoor, Ramesh, B. of Ae.E.

Silence

Jet Engine

Roar



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And, in these shock-absorbing landing struts, alloy steels help cushion the impact of nearly 180 tons of long-distance bomber as it wallops the runway at over 100 miles an hour.

Alloy steels are extra strong . . . exceptionally high in strength-to-weight ratio. They permit production of relatively lightweight high-speed equipment with no sacrifice of strength and safety.

They are tough enough to withstand impact, shock, strain, vibration and sudden stress reversal. They resist the attack of fatigue. They maintain their great strength at wide temperature extremes.

They are uniform in response to heat-treatment . . . produce hard, wear-resistant surfaces around tough cores.

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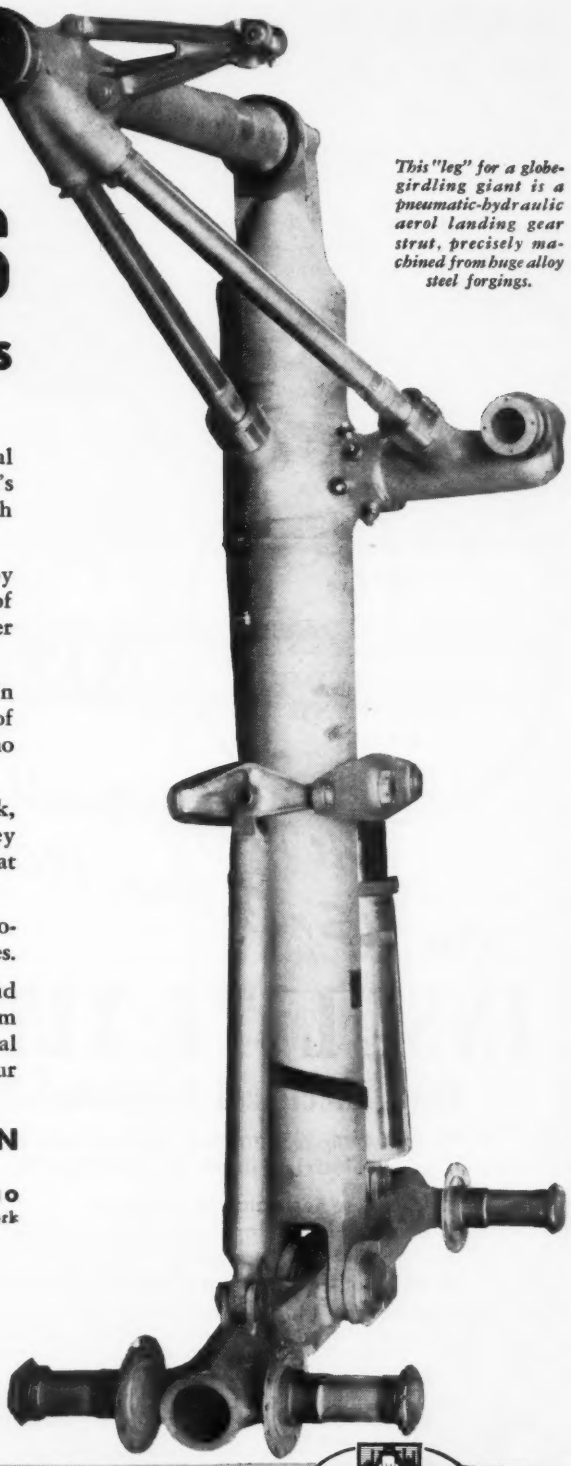
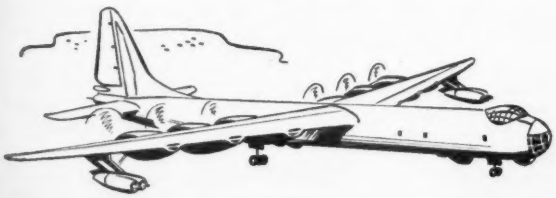
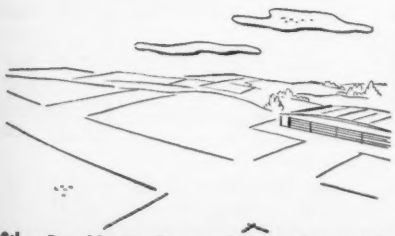


This "leg" for a globe-girdling giant is a pneumatic-hydraulic aerol landing gear strut, precisely machined from huge alloy steel forgings.





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Blaisdell, John D., Design Draftsman, Douglas Aircraft Co., Inc. (Santa Monica).

Boggs, Bernard C., B.S.A.E., Project Engineer, Air Research & Development Command, Wright-Patterson Air Force Base.

Boisseau, Peter C., B.S., Aero. Research Intern GS-5, N.A.C.A., Langley Air Force Base.

Brower, William B., Jr., M.Ae.E., Research Engineer "B," Vibration & Flutter Group, North American Aviation, Inc.

Burnett, Howard R., B.S.A.E., Graduate Asst., University of Illinois.

Carboni, Remo, M. of Ae.E., Aero. Engineer GS-7, N.A.D.C. (Johnsville).

Charwat, Andrew F., M.S., Instructor, University of California.

Cihi, John J., B. of Ae.E., Engineer, Hydraulic & Mech. Dept., Simmonds Aerocessories, Inc.

Clark, Oliver W., B.S.A.E., Flight Test Analyst "B," Boeing Airplane Co. (Wichita).

Clift, William E., A.A. in Ae.E., Student, Spartan College of Aero. Engineering.

Cross, Adelbert D., B.S.M.E., Lt. Colonel, U.S.A.F.; Chief of Production Section, Hq., Southern Air Procurement District (Ft. Worth).

Davies, Duane W., B.Aero.E., 2nd Lt., U.S.A.F., Wright-Patterson A.F.B.

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Dickman, Glen J., B. of Ae.E., Jr. Engineer, Wing Design Group, Consolidated Vultee Aircraft Corp. (Ft. Worth).

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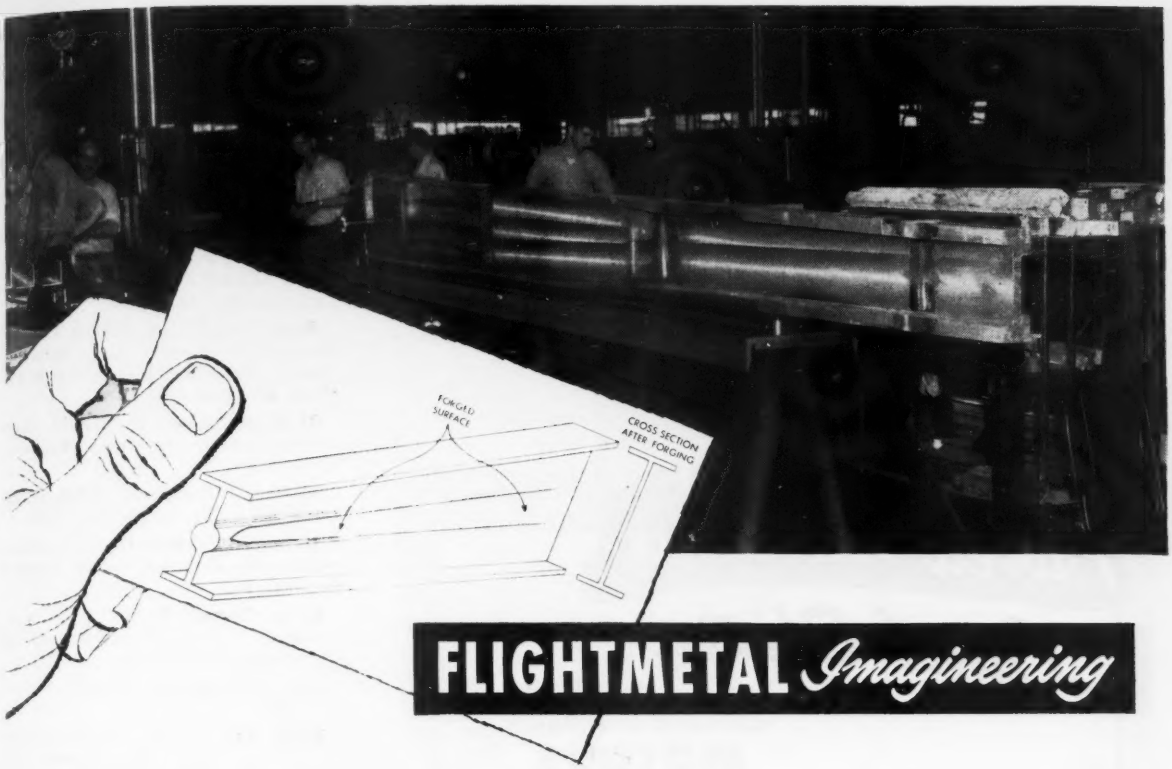

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Preece, Oral J., B.S., Engineer, Tooling Design, Domanco Corp.

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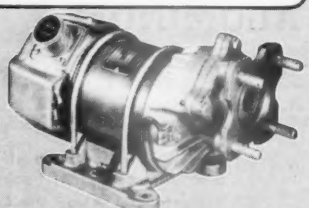

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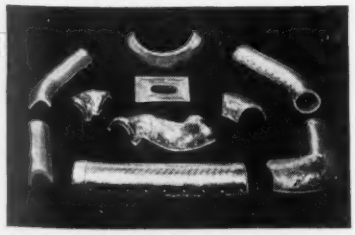

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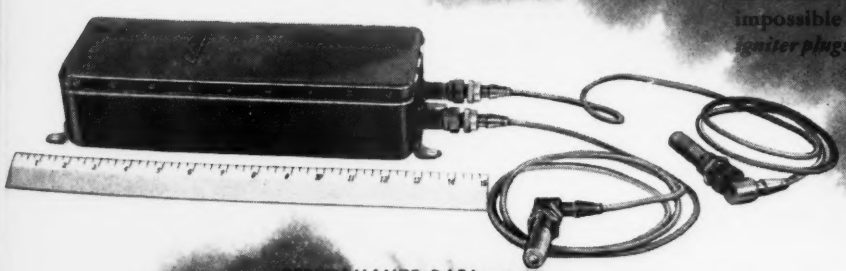

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SPOTLIGHT IN KOREA

CARGO PLANE GUIDES AIR DROP IN STORM

AN AIR BASE IN JAPAN, Jan. 11—Flying Boxcars dropped critically needed supplies to infantrymen in Korea last night during a snow storm so dense one of the big planes had to circle the area for four hours to guide the others to the right place.

The pilot who flew his loaded C-119 from this air base, said he arrived at the designated spot after fighting a heavy snow storm for two hours and dropped his cargo.

With darkness closing in the pilot realized other transports would have a hard time finding the area.

He climbed to 4,000 feet, leveled off and circled. His co-pilot contacted other C-119s en route to the drop zone. As each plane of the 314th Combat Cargo Wing reached the area, the hovering plane flashed on its landing lights. The other planes then swooped down and dropped their cargoes.

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B.F.Goodrich

Weight taken from plane's brakes goes into its wallop

THE NAVY NEPTUNE tracks down "snorkels" with electronic search equipment that these ordinarily radar-proof subs can't hide from. And it packs a powerful wallop with torpedoes, rockets, cannon, and machine guns.

But carrying all this equipment gave Lockheed designers a problem. Every possible pound had to be trimmed off the Neptune's empty weight. When it came to the wheel and brake assembly, they put the problem up to B. F. Goodrich.

B. F. Goodrich brakes can be designed lighter for a given amount of kinetic energy than any other brake because of expander tube design. The brake lining in new-design B. F. Goodrich Expander Tube brakes is mounted on magnesium shoes—a construction that is lighter, yet gives longer wear. The brake has a new spider-type frame that's both lighter and stronger. And the wheels themselves are light, strong magnesium castings. As a result, B. F. Goodrich wheel and brake assemblies enabled designers of the Lockheed P2V Neptune to save a sizeable amount of weight over other designs.

The BFG brakes also provide smoother, safer landings. They respond smoothly and quickly to minimum pressure, take emergency overloads better, cannot lock or grab. Plane utilization is increased because there's less in-shop time. Loads are evenly distributed, reducing wear on brake parts. Maintenance is cut.

The new B. F. Goodrich wheel and brake assembly is one of many effective solutions to aviation problems developed by B. F. Goodrich research and engineering. *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

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A Guide to the Current Literature of Aeronautical Research and Engineering

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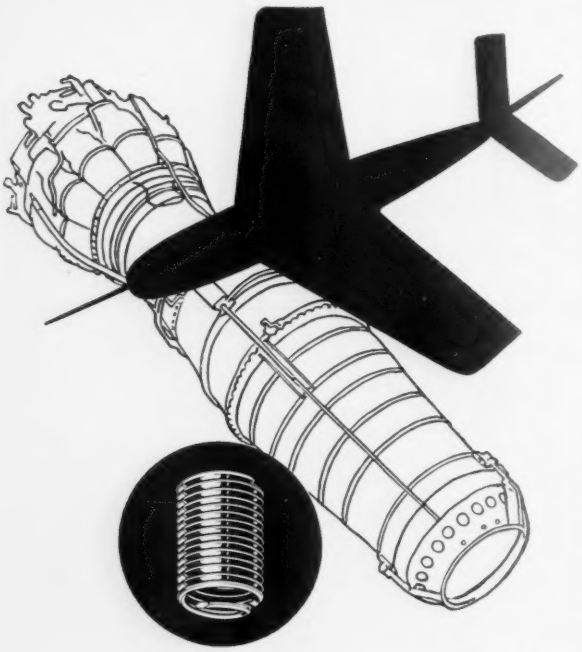

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Aerodynamics (2)

BOUNDARY LAYER

On the Impulsive Motion of a Flat Plate in a Viscous Fluid. K. Stewartson. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 182–198. 6 references.

Study of the motion in the boundary layer when a semi-infinite flat plate is started to move with constant velocity in a fluid at rest at infinity. Approximate solutions are found by using Rayleigh's method of linearizing the boundary-layer equations and by a method using the momentum integral. A solution is developed for the region of $Ut = x$. The solutions are also obtained for a compressible fluid.

Flow Separation Ahead of Blunt Bodies at Supersonic Speeds. W. E. Moeckel. *U.S., N.A.C.A., Technical Note No. 2418*, July, 1951. 39 pp., illus. 4 references. Qualitative analysis of supersonic flow against blunt bodies in wakes or boundary layers.

Investigation of NACA 64,2-432 and 64,3-440 Airfoil Sections with Boundary-Layer Control and an Analytical Study of Their Possible Applications. Elmer A. Horton, Stanley F. Racisz, and Nicholas J. Paradiso. *U.S., N.A.C.A., Technical Note No. 2405*, July, 1951. 40 pp., illus. 10 references.

Investigation in the Langley two-dimensional low-turbulence tunnel to study the effects of boundary-layer control by suction on the aerodynamic characteristics of the airfoils. The results are applied to determine the effect of boundary-layer control and increased aspect ratio on the lift-drag ratio of structurally similar wings of various taper ratios.

CONTROL SURFACES

Effect of Horizontal-Tail Size and Tail Length on Low-Speed Static Longitudinal Stability and Damping in Pitch of a Model Having 45° Sweptback Wing and Tail Surfaces. Jacob H. Lichtenstein. *U.S., N.A.C.A., Technical Note No. 2382*, June, 1951. 32 pp., illus. 9 references.

Effect of Horizontal-Tail Location on Low-Speed Static Longitudinal Stability and Damping in Pitch of a Model Having 45° Sweptback Wing and Tail Surfaces. Jacob H. Lichtenstein. *U.S., N.A.C.A., Technical Note No. 2381*, June, 1951. 26 pp., illus. 7 references.

Flight Investigation of the Effect of Control Centering Springs on the Apparent Spiral Stability of a Personal-Owner Airplane. John P. Campbell, Paul A. Hunter, Donald E. Hewes, and James B. Whitten. *U.S., N.A.C.A., Technical Note No. 2413*, July, 1951. 46 pp., illus. 3 references.

FLUID MECHANICS & AERODYNAMIC THEORY

On an Equation Occurring in the Harmonic Analysis of Viscous Fluid Flow. Richard Bellman. *Quarterly of Applied Mathematics*, Vol. 9, No. 2, July, 1951, pp. 218–223. 2 references.

An Introduction to the General Equations of Fluid Dynamics. G. N. Patterson. *University of Toronto, Institute of Aerophysics, UTIA Review No. 3*, December, 1950. 71 pp., illus.

Development of the general form of the equations of motion. The vector algebra and calculus used in their development are reviewed, and the orthogonal coordinate systems are explained.

An Investigation of Flow Through Screens. W. D. Raines and E. G. Peterson. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 467–480, illus. 11 references.

Analysis and experimental study of flow through screens. Expressions obtained for the pressure drop, velocity modification, and turbulence parameters as functions of the screen geometry are presented in the form of dimensionless graphs.

Note on the Hamel-Synge Theorem. F. H. van den Dungen. *Quarterly of Applied Mathematics*, Vol. 9, No. 2, July, 1951, pp. 203, 204. 1 reference. Extension to three-dimensional motion of Synge's theorem for a plane motion of a compressible viscous fluid.

Some Aspects of Rayleigh's Problem for a Compressible Fluid. L. Howarth. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 157–169. 5 references.

Analysis of the initial motion of an infinite plane that is started to move from rest in a direction parallel to itself in a com-

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pressible fluid, assuming a perfect gas as the medium. The solution associated with the actual dissipation is obtained for the pressure-time variation at a Prandtl Number of 3/4, including the effects of conductivity.

A Preliminary Study of Reynolds Number Effects on Base Pressure at $M = 2.95$. Seymour M. Bogdonoff. *Princeton University, Aeronautical Engineering Laboratory, Report No. 182,* June 12, 1951. 33 pp., illus. 1 reference.

Results of tests on a simple cone-cylinder body in the Princeton 4- by 8-in. variable-density blow-down supersonic tunnel. Test Reynolds Number range was 0.6×10^6 to 18×10^6, based on body length. The effect of several transition bands was also studied. Brief descriptions of the tunnel and the models are included.

Pressure Distribution on Thin Bodies of Revolution at Supersonic Speeds (Preliminary). Ernest W. Graham. *Douglas Aircraft Company, Inc., Report No. SM-20034,* November 26, 1945. 18 pp., illus. 4 references.

Flow Separation Ahead of Blunt Bodies at Supersonic Speeds. W. E. Moeckel. *U.S., N.A.C.A., Technical Note No. 2418,* July, 1951. 39 pp., illus. 4 references.

Qualitative analysis of supersonic flow against blunt bodies in wakes or boundary layers. A detached shock and a region of dead air are formed ahead of the body. The nature of the equilibrium that determines the size of the wedge- or cone-shaped separation region ahead of the body and the limits in which the separation exists are investigated. Tests were made of the flow against blunt bodies mounted on a flat plate in the region of $M = 1.73$–2.02.

On a Problem of Interaction of Plane Waves of Finite Amplitude Involving Retardation of Shock-Formation by an Expansion Wave. P. M. Stocker. *Quarterly Journal of Mechanics and Applied Mathematics,* Vol. 4, Part 2, June, 1951, pp. 170–181, illus. 5 references.

Calculation of the interaction of a receding compression and an advancing expansion wave in the isentropic unsteady flow of an inviscid gas; analysis of the limit-line (shock-wave) formation.

The Production and Stability of Converging Shock Waves. Robert W. Perry and Arthur Kantrowitz. *Journal of Applied Physics,* Vol. 22, No. 7, July, 1951, pp. 878–886, illus. 5 references.

Review of G. Guderley's analysis of converging shock waves; consideration of their stability; production of the waves in an axially symmetric shock tube. Schlieren photographs show various phases of the formation and stability of the converging waves.

Studies on Two Dimensional Transonic Flows of Compressible Fluid. III. S. Tomotika and K. Tamada. *Quarterly of Applied Mathematics,* Vol. 9, No. 2, July, 1951, pp. 129–147, illus. 7 references.

Development of a theory applicable to a transonic flow that contains both limited supersonic regions and stagnation points. The analysis is carried out by introducing a hypothetical gas that represents the real gas during an isentropic flow.

INTERNAL FLOW

Influence of Reynolds Number on Performance of Turbomachinery. Hunt Davis, Harry Kottas, and A. M. G. Moody. *American Society of Mechanical Engineers, Transactions,* Vol. 73, No. 5, July, 1951, pp. 499–503, Discussion, pp. 503–509, illus. 11 references. Dimensional analysis of turbomachinery performance; correlation of previously reported data on the effects of Reynolds Number.

Method of Analysis for Compressible Flow Past Arbitrary Turbomachine Blades on General Surface of Revolution. Chung-Hua Wu and Curtis A. Brown. *U.S., N.A.C.A., Technical Note No. 2407,* July, 1951. 42 pp., illus. 24 references.

Development of a method for analyzing the detailed compressible flow in a typical turbine cascade with highly cambered thick blades. The equations of continuity and motion for irrotational absolute flow are obtained for the flow in the turbomachine and are combined into a second-order nonlinear partial differential equation. Numerical solutions are obtained by the finite-difference method.

Experimental Investigation of Flow in the Rotating Passages of a 48-Inch Impeller at Low Tip Speeds. Donald J. Michel, Ambrose Ginsburg, and John Mizisin. *U.S., N.A.C.A., Research Memorandum No. E51D20,* June 26, 1951. 37 pp., illus. 4 references. Measurement of total and static pressures at tip speeds of 500 and 700 ft. per sec. over a range of weight flow from choking to surge.

Analytical Investigation of Fully Developed Laminar Flow in Tubes with Heat Transfer with Fluid Properties Variable Along the Radius. Robert G. Deissler. *U.S., N.A.C.A., Technical Note No. 2410,* July, 1951. 28 pp., illus. 7 references.

Equations for the velocity and temperature distributions in a laminar flow of gases or liquid metals through a tube are derived for the fully developed boundary layer. The Nusselt Number and friction parameter are obtained from the equations.

Aerodynamics of Ducted Bodies at Supersonic Speeds. F. H. Clauser. (*The Johns Hopkins University, Symposium,* December 6, 1945.) *Douglas Aircraft Company, Inc., Report No. SM-20076,* January 10, 1946. 23 pp., illus.

Suction Force on the Lip of a Two-Dimensional Idealized Scoop in Non-Viscous Subsonic Flow. Charles W. Coale. *Douglas Aircraft Company, Inc., Report No. SM-13742,* April 11, 1950. 17 pp., illus. 4 references.

Calculation of the suction force of a scoop for incompressible and subsonic compressible flows. The behavior of the force coefficient and its value at $M = 1$ are estimated.

Orifice Meters with Supercritical Compressible Flow. R. G. Cunningham. *American Society of Mechanical Engineers, Transactions,* Vol. 73, No. 5, July, 1951, pp. 625–637. Discussion, pp. 637–638, illus. 32 references. Investigation of the flow characteristics of square-edged orifice meters over a pressure-ratio range of 1.0 to 0.13 for both high and low approach velocities; comparison with theory.

PERFORMANCE

Minimal Problems in Airplane Performance. Boris Garfinkel. *Quarterly of Applied Mathematics,* Vol. 9, No. 2, July, 1951, pp. 149–162. 2 references.

Development of the theory of operating an airplane to minimize an arbitrary function of the end-values of the generalized coordinates. A propeller-driven aircraft is considered to be a particle in equilibrium on which lift, drag, thrust, and gravity forces are acting. The problems considered involve minimizing flight time, range, altitude, and fuel consumption, and maximizing the profit and transport utility. Solutions are obtained by the Calculus of Variations.

The Thrust Method of Aircraft Performance Estimation. D. A. MacLulich. *Canada, Royal Canadian Air Force, Experimental and Proving Establishment, Rockcliffe, Report No. 963 (Final D 66/2),* April, 1951. 25 pp., illus. 5 references.

Lift and drag curves for the aircraft are used to obtain the propulsive efficiency for each test run. Analysis of the propulsive efficiency results in graphs of the efficiency index over the propeller advance, effect of c.g. position, and effect of radiator flaps or cowl gills. From these graphs, the aerodynamic performance of the aircraft is determined. The method is illustrated for a Dakota 4.

STABILITY & CONTROL

Bench-Test Investigation of the Transient-Response Characteristics of Several Simulated Airplanes Incorporating an Autopilot Sensitive to Yawing Accelerations. Donald A. Howard. *U.S., N.A.C.A., Technical Note No. 2395,* July, 1951. 27 pp., illus. 4 references.

Study of the limitations of the assumption of a constant time lag in autopilot-airplane systems. Quantitative response data measurements were made to obtain the yawing characteristics of four different airplanes simulated by a mass-spring system.

WINGS & AIRFOILS

The Indicial Lift and Pitching Moment for a Sinking or Pitching Two-Dimensional Wing Flying at Subsonic or Supersonic Speeds. Harvard Lomax, Max. A. Heaslet, and Loma Sluder. *U.S., N.A.C.A., Technical Note No. 2403,* July, 1951, 56 pp., illus. 14 references.

Calculation of the effects of compressibility on the indicial responses. Lift and pitching moment curves are computed for free-stream Mach Numbers of 0, 0.8, 1.0, 1.2, and 2.0. The analysis is based on the two-dimensional wave equation with boundary conditions specified over the plane in which the wing moves.

Über die Koppelkurven des Zwillingskurbeltriebes. Walther Meyer zur Capellen. *Zeitschrift für angewandte Mathematik und Physik,* Vol. 2, No. 3, May, 1951, pp. 189–207, illus. 7 ref-

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erences. In German. Singular properties and construction of connecting curves of twin crank gear. These curves may be used to set up wing and turbine-blade contours.

Über die Wirksamkeit von Flügelendklappen. Nikolaus Rott. *Zeitschrift für angewandte Mathematik und Physik*, Vol. 2, No. 3, May, 1951, pp. 208–212, illus. 2 references. In German. Approximate calculation of aerodynamic forces on wing end-plate.

Full-Scale Investigation of the Maximum Lift and Flow Characteristics of an Airplane Having Approximately Triangular Plan Form. Herbert A. Wilson, Jr., and J. Calvin Lovell. *U.S., N.A.C.A., Research Memorandum No. L6K20*, February 12, 1947. 23 pp., illus. 7 references.

Aeroelasticity

A Third Order Boundary Value Problem Arising in Aeroelastic Wing Theory. George Seifert. *Quarterly of Applied Mathematics*, Vol. 9, No. 2, July, 1951, pp. 210–218. 4 references. Analysis of the boundary conditions in problems of chordwise divergence or sweptforward wing-bending divergence.

Single-Degree-of-Freedom-Flutter Calculations for a Wing in Subsonic Potential Flow and Comparison with an Experiment. Harry L. Runyan. *U.S., N.A.C.A., Technical Note No. 2396*, July, 1951. 27 pp., illus. 7 references.

Study of single-degree-of-freedom flutter associated with the pitching of an airfoil about various locations of the axis of rotation, including the effects of Mach Number (up to $M = 0.7$) and structural damping. Calculations, based on two-dimensional force coefficients, were compared with test results on an airfoil of aspect ratio 5.87 and at $M = 0.06$–0.3.

Problems in Aircraft Dynamic Response. James B. Rea. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 26–28, 88, 90, illus. 4 references.

Investigation of the Fatigue Strength of Full-Scale Airplane Wing Structures. Dwight O. Fearnow. *U.S., N.A.C.A., Research Memorandum No. L51D12a*, July 13, 1951. 30 pp., illus. 7 references. Instrumentation; test procedure and apparatus for fatigue-strength studies using the resonant-frequency method on full-scale C-46 airplane wings; analysis of test results.

Structural Damping with Complex Stiffness. H. R. Grummann and R. E. Newton. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 22, 70, 74–76, 78, 80, 84, illus. 4 references. Analysis of the transient motion of one-degree-of-freedom systems subjected to sinusoidal excitation; review of the solution for the system with viscous damping.

Vibrations of a Clamped Circular Plate Carrying Concentrated Mass. R. E. Roberson. *American Society of Mechanical Engineers, Applied Mechanics Division, West Coast National Conference, Stanford, Calif., June 22, 23, 1951, Paper No. 51-APM-5.* 4 pp., illus. 3 references.

Analysis of the vibrations of a circular plate clamped at its edges to a rigid form and carrying a concentrated mass at its center; the plate is excited by a motion of the framing. The mass is replaced by a density impulse, and the vibration equations are solved by the method of Laplace transform, resulting in an explicit equation for the motion of the concentrated mass. The first four natural frequencies are found as functions of the mass ratio. The response is found for subsystems with one degree of freedom, one subsystem attached to the framing and the other to the concentrated mass.

Air Transportation (41)

Airlines of the World. *The Aeroplane*, Vol. 80, No. 2082, June 15, 1951, pp. 723–752, illus., maps. Survey of the world's air-transport industry; data on air lines (listed alphabetically by continent); tabulation of passenger and freight mileage and fleet equipment and staff.

A Guide to Air Shipping Via the Port of New York. *Port of New York Authority, Department of Airport Development*, July, 1951. 28 pp., tables. Economics and mechanics of routing air cargo through the Port of New York from inland points; problems involved; tables of rates and specific shipping data.

CAB Rules on Freedom of "Assembly," and Distribution of Air Cargo. John H. Frederick. *Distribution Age*, Vol. 50, No. 7, July, 1951, pp. 27, 44, 45, illus.

Air Transport: Then and Now. H. E. Shelton. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 9–15, illus. Statistics of 40 I.A.T.A. member air lines, 1937–1950.

Airplane Design (10)

AIRPLANE DESCRIPTIONS

Avro (Canada) C.102 Jetliner 4-Engined Turbojet Transport (Turbojet Aircraft with Special Reference to the Jetliner). E. H. Atkin. *American Society of Mechanical Engineers, Semi-Annual Meeting, Toronto, June 11–14, 1951, Paper No. 51-SA-23.* 14 pp., illus. 2 references. Factors to be considered in the economics of jet transportation; speed trends.

Bell X-5 Single-Engined Turbojet Variable-Wing-Sweepback Aircraft. *American Helicopter*, Vol. 23, No. 7, June, 1951, pp. 11, 17, 18, illus.

MiG-15 Single-Engined Turbojet Fighter, U.S.S.R. (I Designed the MiG-15). Mikhail I. Gurevich. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 17–19, 40, 42, 44, illus.

Short Sealand 8-Place Twin-Engined Amphibian, England. *Flight*, Vol. 59, No. 2213, June 22, 1951, pp. 733–735, 743, illus.

Texas A.&M.-C.A.A. Ag-1 Single-Engined Agricultural Airplane. *Aviation Week*, Vol. 55, No. 3, July 16, 1951, pp. 42, 47, 49, illus.

BODY GROUP

Design of Aircraft Loading Ramps. George H. Ikola. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 100–105, illus.

Design and operation of two ramps that are built into the nose section of the Douglas C-124A cargo plane. When lowered, the ramps have a 17° slope relative to the ground. In flight, they fold to a vertical position in the forward section of the aircraft; two clam-shell doors close the nose opening. Cutaway drawings show the mechanism that operates the ramps and the nose doors.

DEVELOPMENT TESTING

Temperature Testing the B-36. R. C. Sebold. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 20, 21, 44, 46, 50, illus.

Problems involving equipment operation, brittleness of materials, rubber deterioration, and lubrication encountered in flights of the Convair B-36 in the low-temperature regions (approximately −100°F.) of the stratosphere.

LANDING GEAR

Evaluation of the Reduced-Mass Method of Representing Wing-Lift Effects in Free-Fall Drop Tests of Landing Gears. Benjamin Milwitzky and Dean C. Lindquist. *U.S., N.A.C.A., Technical Note No. 2400*, July, 1951. 43 pp., illus. 3 references.

The results of reduced-mass drop tests of landing gear are compared with data from simulated air-borne impacts and free-fall drop tests. Total dropping weight was 2,500 lbs.; vertical velocities at contact ranged from 3 to 12 ft. per sec.

Landing Gear: Shock Absorbers and Drop Testing. II—Drop Testing. John F. Ceccarelli. *Hydraulic Engineer*, Vol. 1, No. 2, June-July, 1951, pp. 4, 5, 8, illus. A typical drop-test setup for the main landing gear of an Air Force jet fighter; calculations.

Airports & Airways (39)

Aluminum-Alloy Hangar: A Three-Bay, 125-Ft. Clear-Span Structure at London Airport. *Aircraft Production*, Vol. 13, No. 153, July, 1951, pp. 227, 228, illus.

Simplified Hydrant Refueling Systems. Walter Palmer. *Esso Air World*, Vol. 3, No. 6, May-June, 1951, pp. 160, 161, illus.

Aviation Medicine (19)

Physics and Psychophysics of Weightlessness. H. Haber and S. J. Gerathewohl. *Journal of Aviation Medicine*, Vol. 22, No. 3, June, 1951, pp. 180–189, illus. 6 references. Problems associated with the subgravity and zero-gravity states.

Studies on Microorganisms of the Upper Atmosphere. I—Development of Methods and Material. Roland B. Mitchell, Durward E. Timmons, and Harry W. Dorris, Jr. *Journal of Aviation Medicine*, Vol. 22, No. 3, June, 1951, pp. 214–224. 12 references.

Parallel Production of Altered Infectivity of a Streptococcus and Related Filterable Agents Isolated from Outdoor Air.

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(Age-hardened condition)

Test Temperature °F.	Yield Strength (0.20% offset) psi.	Tensile Strength psi.	Elongation in 2 in. per cent	Creep Strength (0.10% in 10,000 hr.) psi.	Hardness (Brinell)	Impact (Charpy) ft.-lb.
−300	160,200	202,000	27	...	...	...
−110	134,600	171,550	17.3	...	36 (Rock. C)	27
Room	111,000	160,000	23.5	...	331	27
200	108,000	150,000	23.5	...	...	...
400	103,000	149,000	24	...	...	...
600	105,000	146,000	23	...	...	...
750	...	...	...	67,000	...	...
800	105,000	124,000	8.5	48,000	302	...
1000	92,000	95,000	3	8,500	255	...
1100	...	...	...	...	229	...
1200	80,000	80,000	1.5	...	...	...
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FURTHER DATA AVAILABLE

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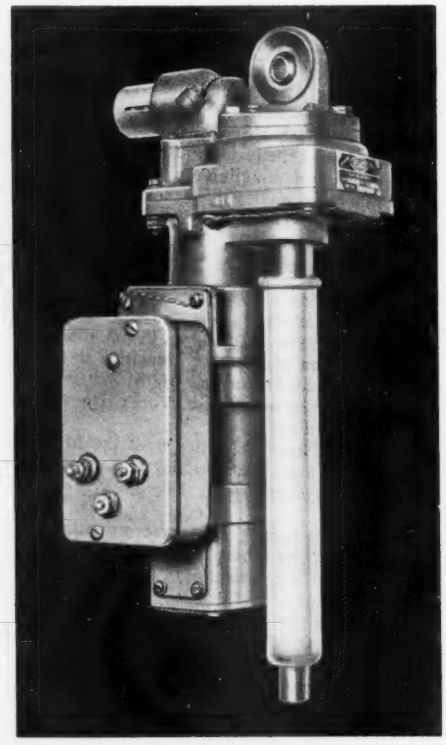

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An Instrument for Recording the Frequency Drift of an Oscillator. W. W. Boelens. *Philips Technical Review*, Vol. 12, No. 7, January, 1951, pp. 193–199, illus. 1 reference.

Design of a recording drift meter that automatically plots the drift curve. The meter was designed for testing FM radio receivers of an effective frequency range of 88–108 mc. The meter records the absolute value of the difference between a standard frequency and the oscillator frequency. A block diagram of the complete apparatus and circuit diagrams of the individual components are given.

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Design of an instrument by which the response of an impedance or a network to a current in the form of a unit function is traced on the screen of a cathode-ray tube. Circuit diagrams show the multivibrator that furnishes the unit function and the oscilloscope. Applications explained include investigations of a resistance, resistance and capacitance in parallel, resistance and self-inductance in parallel, L-C circuits, and band-pass and low-pass filters.

An Instrument for Recording the Frequency Drift of an Oscillator. W. W. Boelens. *Philips Technical Review*, Vol. 12, No. 7, January, 1951, pp. 193–199, illus. 1 reference.

Design of a recording drift meter that automatically plots the drift curve. The meter was designed for testing FM radio receivers of an effective frequency range of 88–108 mc. The meter records the absolute value of the difference between a standard frequency and the oscillator frequency. A block diagram of the complete apparatus and circuit diagrams of the individual components are given.

NAVIGATION AIDS

Correspondence: Experimental Results of Continuous-Wave Navigation Systems. Fred S. Howell. *Institute of Radio Engineers, Proceedings*, Vol. 39, No. 7, July, 1951, p. 841. 4 references.

NOISE & INTERFERENCE

The Distribution of Energy in Randomly Modulated Waves. David Middleton. *Philosophical Magazine*, Vol. 42 (7th Series), No. 330, July, 1951, pp. 689–707, illus. 14 references. Analysis of a carrier phase- or frequency-modulated by noise, and of a carrier amplitude-modulated by noise; presentation of theory and measurements from recent research.

Direct-Reading Noise-Factor Measuring Systems. R. W. Peter. *RCA Review*, Vol. 12, No. 2, June, 1951, pp. 269–281, illus. 8 references.

Methods to Extend the Frequency Range of Untuned Diode Noise Generators. Harwick Johnson. *RCA Review*, Vol. 12, No. 2, June, 1951, pp. 251–257, illus. 1 reference.

TRANSMISSION LINES

A Measuring Arrangement for Waveguides. A. E. Pannenborg. *Philips Technical Review*, Vol. 12, No. 1, July, 1950, pp. 15–24, illus. 9 references.

Brief review of the propagation of waves in waveguides and of the occurrence of standing waves; design and operation of a probe to measure wave-guide reflections, for waves with a length between 1 mm. and 30 cm.

WAVE PROPAGATION

The Absorption of Long and Very-Long Waves in the Ionosphere. J. P. Stanley. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 2, 1950, pp. 65–72, illus. 9 references.

Determination of Electron Densities in the Ionosphere from Experimental (h', f) Curves. H. A. Whale. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 4, 1951, pp. 244–253, illus. 10 references.

Group and Phase Velocities from the Magneto-Ionic Theory. H. A. Whale and J. P. Stanley. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 2, 1950, pp. 82–94, illus. 11 references.

Über die Dämpfung der ausserordentlichen Komponente in der E_1-Schicht der Ionosphäre. Walter Becker. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 2, 1950, pp. 37–81, illus. 4 references. In German. The absorption of extraordinary components in the E_1-layer of the ionosphere.

Ionosphere Over Calcutta (Solar Half-Cycle, January, 1945–June, 1950). S. S. Baral and A. P. Mitra. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 2, 1950, pp. 95–105, illus. 26 references.

Studies of the F_2 Layer in the Ionosphere. I—The Position of the Ionospheric Equator in the F_2 Layer. Edward Appelton. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 2, 1950, pp. 106–113, illus. 5 references.

Fine Structure of the Ionospheric Region E. H. A. Whale. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 4, 1951, pp. 233–243, illus. 12 references.

Correspondence: The Permittivity of Air at a Wavelength of Ten Centimeters. J. V. Hughes and W. Lavrench. *Institute of Radio Engineers, Proceedings*, Vol. 39, No. 7, July, 1951, p. 839, illus. 1 reference.

Remarks Concerning Wave Propagation in Stratified Media. S. A. Schelkunoff. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 117–128, illus. 3 references.

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Extension of Weyl's Integral for Harmonic Spherical Waves to Arbitrary Wave Shapes. H. Poritsky. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 33–42, illus.

On the Diffraction Theory of Gaussian Optics. H. Bremmer. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 61–74, illus. 3 references.

Diffraction and Reflection of Pulses by Wedges and Corners. Joseph B. Keller and Albert Blank. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 75–94, illus. 5 references.

Vector Wave Functions. R. D. Spence and C. P. Wells. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 95–104, illus. 4 references.

The Theory of Magneto Ionic Triple Splitting. O. E. H. Rydbeck. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 129–160, illus. 16 references.

The W.K.B. Approximation As the First Term of a Geometric-Optical Series. H. Bremmer. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 105–115, illus. 2 references.

Equipment

ELECTRIC (16)

Power Leads for Fractional Hp Motors. A. L. Ulmer. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 135–138, illus.

HYDRAULIC & PNEUMATIC (20)

Aircraft Boost Valve Characteristics. J. C. Monroe. *Applied Hydraulics*, Vol. 4, No. 7, July, 1951, pp. 50–52, illus. Valve characteristics of a closed center system; static and dynamic calibration methods; problems caused by entrapped air.

Synchronizing Piston Movement in Hydraulic Cylinders. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 156, 157, illus.

Sketches of seven circuits which show methods of causing two or more hydraulically operated pistons to extend and retract in perfect synchronism; factors that can upset the synchronism.

Designing an Integral Dashpot for a Hydraulic Cylinder. William E. Soong. *Machine Design*, Vol. 23, No. 7, July, 1951, pp.129–132, 198, illus.

The impact at end of stroke is absorbed by controlled flow through radial metering-pin orifices; the design uses a straight hollow pin with radially drilled orifices rather than a tapered pin. Test results show close agreement with design conditions.

The Hydraulic Fluid That Will Not Burn. George L. Christian. *Aviation Week*, Vol. 55, No. 3, July 16, 1951, pp. 54, 57, 58, 61, illus. Properties of nonflammable H-2 hydraulic fluid, developed by R. M. Hollingshead Corp.

Flight Operating Problems (31)

ICE PREVENTION & REMOVAL

A Simplified Instrument for Recording and Indicating Frequency and Intensity of Icing Conditions Encountered in Flight. Porter J. Perkins, Stuart McCullough, and Ralph D. Lewis. *U.S., N.A.C.A., Research Memorandum No. E51E16*, July 3, 1951. 26 pp., illus. 3 references. Design, and operation for accumulating data on the occurrence, extent, and severity of icing conditions on routine air-line operations.

Further Remarks on Intermittent Heating for Aircraft Ice Protection. Frederick Weiner. *American Society of Mechanical Engineers, Semi-Annual Meeting, Toronto, June 11–14, 1951, Paper No. 51-SA-38.* 12 pp., illus. 7 references.

Solution of the equation for intermittent heat transfer of an internally-heated propeller during icing conditions by an electric analog method; comparison with measured time-temperature data.

An Investigation of a Rotor Blade Thermal Ice-Prevention System for the H-5 Helicopter (Sikorsky). E. F. Katzenberger. *Aeronautical Engineering Review*, Vol. 10, No. 9, September, 1951, pp. 25–33, illus. 8 references.

Flight Safety & Rescue (15)

Considerations in the Design and Installation of Cockpit Check Lists, Placards, and Manuals. David H. Kaplan. **Introduction—Check Lists: "You Can't Remember All You Know."** Jerome Lederer. *Aeronautical Engineering Review*, Vol. 10, No. 9, September, 1951, pp. 10–16, illus. 14 references. Basic design arrangements of check lists; lighting; style of lettering; location in cockpit.

"Seeing Eye" Used to Detect Aircraft Fires. *U.S., Central Air Documents Office (Army-Navy-Air Force), Technical Data Digest*, Vol. 16, No. 7, July, 1951, pp. 2, 3, illus.

A photoelectric fire detector uses a lead sulfide cell that is sensitive to infrared radiation emitted by a flame. The system consists of an amplifier, 9 infrared sensitive detector units, and a test switch assembly. The system responds to infrared intensity variation between 5 and 25 cycles per sec.

Fuels & Lubricants (12)

Fuel–Air Ratio and Intake Air Temperature Control Equipment for Use on Single Cylinder Test Engines. *The Texas Company, Beacon Laboratories, Report No. 503-70E*, April 30, 1951. 31 pp., illus. Data on the construction of a fuel–air ratio controller and a quick-change intake air-temperature controller and summary of operating experience with the units.

Viscosity and Density of Lubricating Oils from 0 to 150,000 Psig and 32 to 425°F. Donald Bradbury, Melvin Mark, and R. V. Kleinschmidt. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 667–672, Discussion, pp. 672–676, illus. 12 references. Summary of research on viscosity of 46 lubricants; apparatus and test methods; typical data.

Gliders (35)

Der Moswey 4a. René Comte. *Schweizer Aero-Revue*, Vol. 26, No. 6, June, 1951, pp. 269, 270, illus. In German.

Guided Missiles (1)

Evolution of the Guided Missile. III—Problems of the Heavyweight Supersonic Rocket; The German A-9/A-10 Projects. Kenneth W. Gatland. *Flight*, Vol. 59, No. 2214, June 29, 1951, pp. 768–770, illus.

Instruments (9)

An Instrument for Automatically Recording Waviness of Surfaces. C. W. Medhurst. *Journal of Scientific Instruments*, Vol. 28, No. 7, July, 1951, pp. 211–214, illus.

Theory, design, and operation of an instrument that automatically and rapidly records the waviness of surfaces on graph paper. It is suitable for production testing. The instrument is used for tests on aircraft wings and wing panel blocks but can be used to study the waviness of any surface.

Control-Surface Position Feedback in Flight-Control Systems. Leonard Becker. *Aeronautical Engineering Review*, Vol. 10, No. 9, September, 1951, pp. 17–19, 33, illus. 1 reference. Brief review and outline of the characteristics and effects of the use of constant negative control-surface feedback.

Bench-Test Investigation of the Transient-Response Characteristics of Several Simulated Airplanes Incorporating an Autopilot Sensitive to Yawing Accelerations. Donald A. Howard. *U.S., N.A.C.A., Technical Note No. 2395*, July, 1951, 27 pp., illus. 4 references.

Study of the limitations of the assumption of a constant time lag in autopilot-airplane systems. Quantitative response data measurements were made to obtain the yawing characteristics of four different airplanes simulated by a mass-spring system.

Nondimensional Study of Proportional-Plus-Reset Control of a Single-Capacity System. J. A. Hrones and J. B. Reswick. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 511–516, Discussion, pp. 516, 517, illus.

Nondimensional study of the problem of a speed governor of a rotating disc in the presence of viscous damping. The transient response of the system was obtained with an analog computer;

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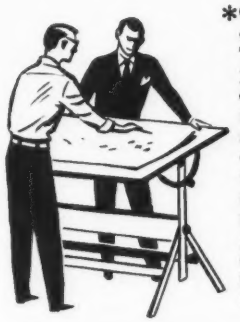

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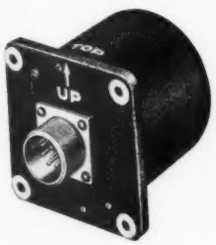

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the results are presented as families of curves in nondimensional form.

On the Regulation of Industrial Processes. H. J. Roosdorp. *Philips Technical Review*, Vol. 12, No. 8, February, 1951, pp. 221–227, illus.

General outline of regulating systems that are closed circuits with automatic controllers; accuracy and dynamic stability of such systems; analysis of an electric model of the regulator.

Graphical Synthesis of Networks for A-C Servos. G. A. Bjornson. *Electrical Engineering*, Vol. 70, No. 7, July, 1951, pp. 571, illus.

Fundamental Studies in Servomechanisms Rated Approximately 100 Watts. *Massachusetts Institute of Technology, Servomechanisms Laboratory, Project No. 6097, Report*, Vols. I, II, September, 1943. 100 pp., illus. 11 references.

General survey of the servomechanism problem, development of a hydraulic and of an all-electric servomechanism, both for application to an automatic fuse setter.

Magnetic Particle and Hysteresis Clutches for Servo Systems. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 176, 177, illus. Advantages, and data on the performance characteristics and dimensions of various models of the Duncan & Bayley magnetic-particle and hysteresis-type clutches.

Optimum Gear Train Ratios for Instrument Servomechanisms. L. N. Canick. *Product Engineering*, Vol. 7, No. 7, July, 1951, pp. 108, 109, illus. Method for determining the optimum gear reduction ratio of a step train; procedure for designing a gear train of minimum inertia.

Calibration of Precision Dynamometers by Means of a Pressure Balance. H. B. Bouwan, A. Visser, D. A. Beekhuis, and F. H. Toneman. (*De Ingenieur*, Vol. 53, No. 6, February 9, 1951, pp. O1–O4.) *The Engineers' Digest*, Vol. 12, No. 6, June, 1951, pp. 183–185, illus. 5 references.

Calibration apparatus consists of a hydraulic press that is coupled to a high-pressure pump and a pressure balance. Operation is demonstrated by calibrating a loop dynamometer of the Wazau type.

An Investigation of a Method to Indicate Atmospheric Turbulence from an Airplane in Flight. H. B. Tolefson and C. A. Gurtler. *U.S., N.A.C.A., Research Memorandum No. L50K29c*, July 9, 1951. 18 pp., illus. 4 references.

Operation, and analysis of test data of an instrument to indicate air turbulence from an airplane in flight. Rapid fluctuations in air speed in gusty air are used to measure the turbulence.

A Simplified Instrument for Recording and Indicating Frequency and Intensity of Icing Conditions Encountered in Flight. Porter J. Perkins, Stuart McCullough, and Ralph D. Lewis. *U.S., N.A.C.A., Research Memorandum No. E51E16*, July 3, 1951. 26 pp., illus. 3 references.

Design, calibration, and operating characteristics. The instrument consists of an ice-collecting unit, a film-recorder unit, and a remote-indicator panel. It operates on differential pressure created when small total-pressure holes in a static-pressure vented system are allowed to plug with ice accretions.

Study of Linear-Resistance Flowmeters. F. W. Fleming and R. C. Binder. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 621–624, illus. 2 references.

Experimental study of the characteristics of linear-resistance flowmeters. Tests were made with pipes having inside diameters of 1.873, 1.383, 0.872, and 0.502 in., using cotton and steel wool as the resistance materials. Characteristic curves show test results.

A Compensated Thermal Anemometer and Flowmeter. C. E. Hastings and C. R. Wcislo. *Electrical Engineering*, Vol. 70, No. 7, July, 1951, p. 597, illus.

A sensitive, accurate thermal anemometer that is almost independent of temperature operates from a heated noble thermopile placed in the air stream. Instruments of this type can measure flow velocities as low as 5 ft. per min. and up to 400 miles per hour.

Discharge Coefficients of Small-Diameter Orifices and Flow Nozzles. H. P. Grace and C. E. Lapple. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 639–647, illus. 4 references.

Discharge coefficients were determined in a standard 1-in. pipe for thick-plate and knife-edge orifices of $^1/_{32}$-in. to $^3/_4$-in. diameter and for critical (sonic) flow nozzles of $^1/_{32}$-in. to $^1/_4$-in. diameter. Details are given of calibration procedures and precision of measurement.

The Electrical Recording of Diagrams with a Calibrated System of Coordinates. B. G. Dammers, P. D. van der Knaap, and A. G. W. Uitjens. *Philips Technical Review*, Vol. 12, No. 10, April, 1951, pp. 283–292, illus. 8 references.

Theory, operation, and components of an instrument in which a lattice-type form of calibrated coordinate system is produced on the oscilloscope screen simultaneously with the tracing of the diagram, giving a means of accurate numerical interpretation of the curves.

A Versatile Bridge System for Use with Wire Resistance Gauges in the Measurement of Slow Transient Strains. M. J. Richard. *Electronic Engineering*, Vol. 23, No. 281, July, 1951, p. 276, illus.

Temperature-Sensing Devices for Jet Engines. Andrew I. Dahl and Ernest F. Fiock. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 23, 94, 95, illus.

Design of an apparatus devoted by the National Bureau of Standards for measuring the response of jet-engine temperature elements under conditions approximating a jet-engine combustion temperature. Cutaway drawings show the entire apparatus and the shielding for the test instrument.

Laws & Regulations (44)

High Altitude Flight and National Sovereignty. John C. Cooper. (*Address delivered before the Escuela Libre de Derecho, Mexico City*, January 5, 1951.) *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 46–50.

International Airmail; A Review of Past Accomplishments and the Future Program of Discussion Between Airlines and Postal Administrations. René Briend. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 34–42.

U.S. Regulation and the C.A.B.; The Position of the Civil Aeronautics Board in American Government Tradition and Structure. Delos Wilson Rentzel. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 21–31, illus.

"This Freedom." Frederick Tymms. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 16–20.

Freedom of air as defined at the Chicago International Conference on Civil Aviation (1944); characteristics of a scheduled air service; need for a common standard for distinguishing between scheduled air services and nonscheduled operations.

Facilitation Prospects; Some Projects by Which IATA's FAL Organization Hopes To Speed Up International Airline Traffic. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 54–70.

IATA Clearing House—1950. Arthur J. Quin-Harkin. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 84–86, illus.

Operating Statistics of IATA Members for 1949. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 87–93.

Machine Elements (14)

Machine Design Data Sheet: Design Factors for Stress Concentration. V—Transverse Holes in Bars and Shafts. R. E. Peterson. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 155–159, illus. 15 references.

Designing for Economical Gasketing. E. C. Frazier. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 139–144, illus. Tables and cutaway drawings show the properties and uses of gasket materials and design suggestions for gasketed joints.

BEARINGS

Performance of Oil-Film Bearings with Abrasive-Containing Lubricant. A. E. Roach. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 677–686, illus. 10 references.

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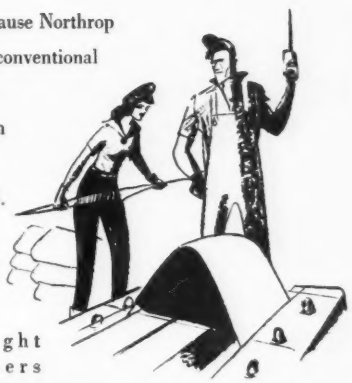

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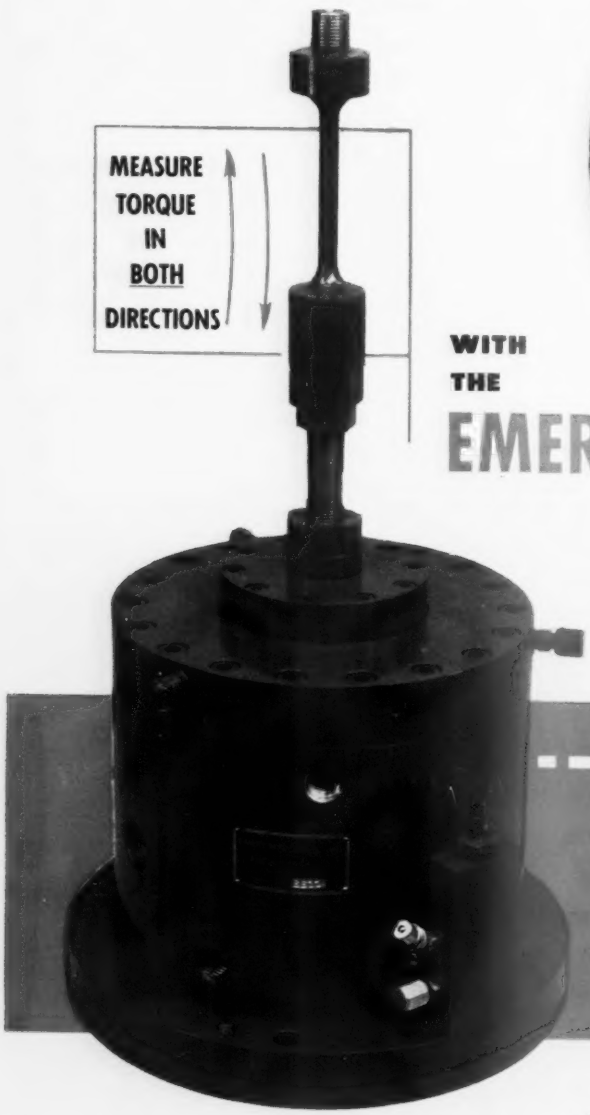

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Experimental study of embedability, effects of abrasive concentration, abrasive-particle size, gridding, oil grooves, copper-lead composition; comparison of the performance of bearing materials; results of tests using the method.

FASTENINGS

Characteristics of Temproof Mountings. Gordon H. Waite and Bruce W. Campbell. *Lord Manufacturing Company, Report No. 242*, March 6, 1951. 10 pp., illus., folding charts. Design specifications and characteristics, test procedure and results, and evaluation of a flexible mounting for base-mounted air-borne equipment.

FRICTION

Determination of the Dynamic Coefficient of Friction for Transient Conditions. G. G. Gould. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 649–654, illus.

Dry friction studies at constant ambient temperature and humidity in which tangential and normal frictional forces were measured as functions of time. Curves show the behavior of the frictional forces under transient conditions for different combinations of friction materials and mating surfaces.

GEARS & CAMS

The Effect of Oil Viscosity on the Power-Transmitting Capacity of Spur Gears. V. N. Borsoff, J. B. Accinelli, and A. G. Cattaneo. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 687–694, Discussion, pp. 694–696, illus. 7 references.

Analysis based on tests made on spur gears with nine lubricants of various viscosities of the Lewis gear design equation, incorporating the lubricant viscosity into the equation. The gear-testing equipment and test procedure are explained.

Shotpeening As a Factor in the Design of Gears. John C. Straub. *Mechanical Engineering*, Vol. 73, No. 7, July, 1951, pp. 565–569, illus. 7 references.

Calculating Cam Profiles; A Simplified Method for Determining Co-Ordinates of Cam Pitch Surfaces. L. Sigfred Linderoth, Jr. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 115–119, illus. 6 references.

Designing Noncircular Surfaces for Pure Rolling Contact. F. W. Hannula. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 111–114, 190, 192, illus. 2 references. Mathematical analysis; outline of procedure for producing the required surfaces.

SHAFTS & ROTATING DISCS

Stresses in Rotating Disks of Nonuniform Thickness. T. H. Gawain and E. C. Curry. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 152–155, illus.

Theory and derivation of the fundamental stress relations. Two trial solutions are calculated and superimposed to satisfy the conditions at the inner and outer edges of the disc; a step-by-step procedure is applied from the inner to the outer edges.

SPRINGS

Designing Wave Springs. Leonard Kulze. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 109, 110, illus.

Materials Engineering File Facts No. 211: Typical Properties of Vanadium Spring Steels. *Materials & Methods*, Vol. 34, No. 1, July, 1951, pp. 113, 115, illus.

Maintenance (25)

Noise Problems Associated with Aircraft Maintenance. Horace O. Parrack and Donald H. Eldredge. *U.S., Central Air Documents Office (Army-Navy-Air Force), Technical Data Digest*, Vol. 17, No. 7, July, 1951, pp. 22–25, illus. 4 references.

Data are presented on the distribution of sound around jet aircraft. Charts show sound levels around F-84 aircraft. The effects of high noise levels on maintenance operations are explained.

Douglas Service, Vol. 9, No. 3, May-June, 1951. 20 pp., illus. DC-4, -6, -6B, and C-47.

Materials (8)

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Ways of overcoming shortages; conserving or replacing specific scarce materials; using alternate materials; manufacturing experiences. Reference tables list specific alternate materials for specific products.

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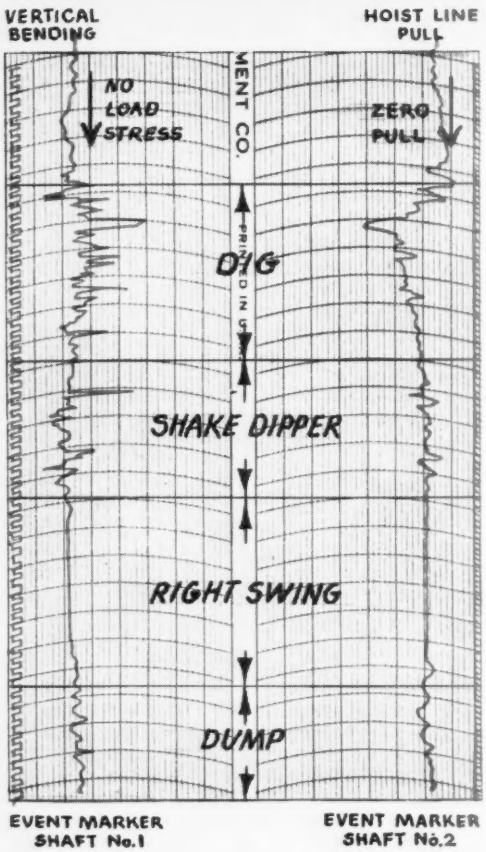

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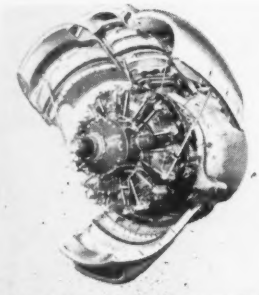

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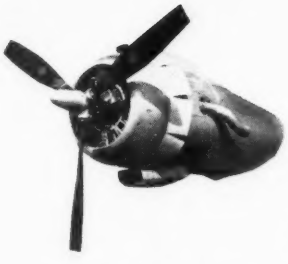

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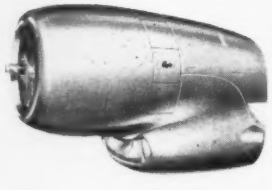

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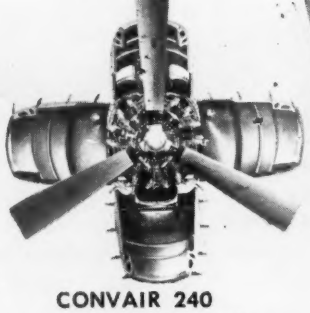

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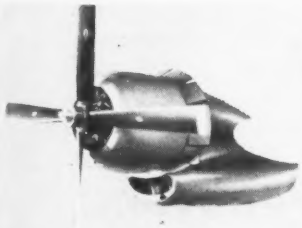

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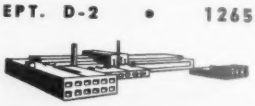
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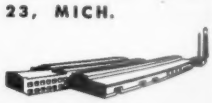
PLANT 4
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Some Aspects of Electrical Computing. II. J. Bell. *Electronic Engineering*, Vol. 23, No. 281, July, 1951, pp. 264–269, illus. Electric setups for various computing processes.

The Electro-Analogue, an Apparatus for Studying Regulating Systems. I—Components and Functions. II—The Electrical Execution. J. M. L. Janssen and L. Ensing. *Philips Technical Review*, Vol. 12, Nos. 9, 11, March, May, 1951, pp. 257–271; 319–335; illus. 13 references.

Almost Periodicity and Non-Absolutely Integrable Functions. H. Burkill. *London Mathematical Society, Proceedings*, Vol. 53 (Series 2), Part 1, January 22, 1951, pp. 32–42. 4 references. Extension of the concept of almost periodicity to functions integrable in the general Denjoy sense and to the summability of their Fourier series.

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Expansion of an arbitrary function in terms of the solutions of the partial differential equation

$$\nabla^2\phi + [\lambda - q(x, y)]\phi = 0$$

considering the whole (x, y) plane. A theory is developed for the bounded region, assuming the region to be a square, and extended to the whole (x, y) plane. Fourier and iterative processes are used.

Solution of Some Partial Differential Equations (with Tables). Louis Weinberg. *Franklin Institute, Journal*, Vol. 252, No. 1, July, 1951, pp. 43–62. 4 references.

Tables of solutions are presented for the Helmholtz and Laplace equations for rectangular, circular cylinder, elliptic cylinder, parabolic cylinder, spherical, prolate spheroidal, oblate spheroidal, and parabolic coordinate solutions. It is shown that Laplace's equation, Poisson's equation, and the diffusion, wave, and damped-wave equations are special cases of the Helmholtz equation.

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Tables of Two Integrals and of Spielrein's Inductance Function. Alan Fletcher. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 223–235. 12 references.

Tables for $\alpha = 0(.01)1$ of

$$I = \int_\alpha^1 (K - E)dk \text{ and } J = \int_\alpha^1 (K - e)k^{-3}dk$$

where K and E are complete elliptic integrals of the first and second kinds with modulus k, and of Spielrein's inductance function, $f(\alpha) = 16\pi/[3(1 - \alpha)^2](I - \alpha^3 J)$.

Transformations of Basic Hypergeometric Functions of Special Type. D. B. Sears. *London Mathematical Society, Proceedings*, Vol. 52 (Series 2), Part 6, April 28, 1949, pp. 467–483. 8 references.

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On Diffusion by Discontinuous Movements, and on the Telegraph Equation. S. Goldstein. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 129–156, illus. 9 references.

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On the Conformal Theory of Curves in a General Differential Metric Space. R. S. Clark. *London Mathematical Society, Proceedings*, Vol. 1 (Series 3), No. 1, March, 1951, pp. 58–70. 5 references.

On Minimal Surfaces with Partially Free Boundary. Hans Lewy. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 1–13. 3 references.

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Structures (7)

Three-Dimensional Photoelasticity. R. C. O'Rourke. *Journal of Applied Physics*, Vol. 22, No. 7, July, 1951, pp. 872–878, illus. 8 references.

Derivation of a variational form of the Maxwell-Neumann law of photoelasticity and of a generalized Hamilton-Jacobi partial differential equation for the phases of the two waves that can propagate with finite velocity in weakly anisotropic and inhomogeneous media. The general problem, in which the principal stress directions in the plane of the wave front rotate arbitrarily as the latter propagates through the medium, is analyzed by the Sommerfeld-Runge method.

Mechanical Vibrator Adjusts Output Force While Running. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 120, 121, illus.

The mechanical vibration exciter, used at The Glenn L. Martin Co., for investigating the vibratory characteristics of aircraft components. Two counter-rotating horseshoe weights move toward and away from their axes of rotation; this varies the force while they are in motion. The output force can be changed without stopping the machine, and any preset value of force can be held automatically over the entire speed range by an electrically-controlled servo system.

The Influence of Compressibility in Elastic-Plastic Bending. J. W. Craggs. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 241–247, illus. 2 references. Flexure of a uniform beam; investigation of the validity of assuming the material to be incompressible—i.e., assuming that all the stress components, except longitudinal tension or compression, are zero.

Graphical Integration. W. L. Vaughn. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 29, 108, illus.

A graphical method of integration of loading curves to obtain shears, moments, and deflections of cantilever beams. The method is easy to apply, involves only two triangles, and gives slide-rule accuracy.

On the Inextensional Theory of Deformation of a Right Circular Cylindrical Shell. R. M. Hermes. *American Society of Mechanical Engineers, Applied Mechanics Division, West Coast*

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National Conference, Stanford, Calif., June 22, 23, 1951, Paper No. 51–APM-2. 4 pp., illus. 7 references.

Evaluation of solutions obtained according to the theory of inextensional bending of cylinders by comparing solutions calculated by the superposition method with experimental results.

On Combined Bending and Twisting of Thin Tubes in the Plastic Range. R. Hill and M. P. L. Siebel. *Philosophical Magazine*, Vol. 42 (7th Series), No. 330, July, 1951, pp. 722–730, illus. 2 references.

Calculation of the angles of bend and twist, the warping of the cross-section, and the instantaneous distribution of stress in a thin-walled circular tube under monotonic loading.

The Moving Griffith Crack. Elizabeth H. Yoffe. *Philosophical Magazine*, Vol. 42 (7th Series), No. 330, July, 1951, pp. 739–750, illus. 6 references.

Calculation of the stresses near the head of a rapidly propagating crack in a plate of isotropic elastic material assuming that the crack has a constant length. The problem reduces to that of a disturbance at constant speed and form in a plate in uniform tension. The solution is obtained from a system of elastic waves which represents the disturbance.

A General Method of Calculating the $M\epsilon_{max.}$ Diagram in Plastic Bending of Beams. Aris Phillips. *American Society of Mechanical Engineers, Applied Mechanics Division, West Coast National Conference, Stanford, Calif., June 22, 23, 1951, Paper No. 51–APM-6.* 6 pp., illus. 13 references. Equations and graphic construction for obtaining the $M\epsilon_{max.}$ curve for symmetric bending of bars in plasticity.

Discussion of "Die Grundlagen der mathematischen Plastizitätstheorie und der Versuch" (Basis of the Mathematical Theory of Plasticity and Experiment), by F. Stüssi. P. P. Bijlaard. **Author's Reply.** *Zeitschrift für angewandte Mathematik und Physik*, Vol. 2, No. 2, March, 1951, pp. 114–119, illus. 11 references. In German.

Charts Giving Critical Compressive Stress of Continuous Flat Sheet Divided into Parallelogram-Shaped Panels. Roger A. Anderson. *U.S., N.A.C.A., Technical Note No. 2392*, July, 1951. 31 pp., illus. 3 references. Charts give theoretical buckling-stress coefficients as functions of panel skewness and aspect ratio for sheet panels of a shape occurring in swept-wing plan forms.

Bending of Thin Ring Sector Plates. L. I. Deverall and C. J. Thorne. *American Society of Mechanical Engineers, Applied Mechanics Division, West Coast National Conference, Stanford, Calif., June 22, 23, 1951, Paper No. 51–APM-1.* 5 pp., illus. 10 references.

The finite Fourier transform is used to find the deflection of a thin homogeneous isotropic plate whose planform is a sector of a circular ring and which has arbitrary but given deflection and bending moments along its straight edges and any physically important edge conditions along its curved edges. Values of the constants are given for the three physically important combinations of edge conditions at the two curved edges.

Calculating Deflection in Circular Plates. William A. Nash. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 145–148, illus. 2 references. Analysis of the problem of unsymmetric distribution of shearing forces or bending moments applied to the edge of a circular plate, applying thin plate theory.

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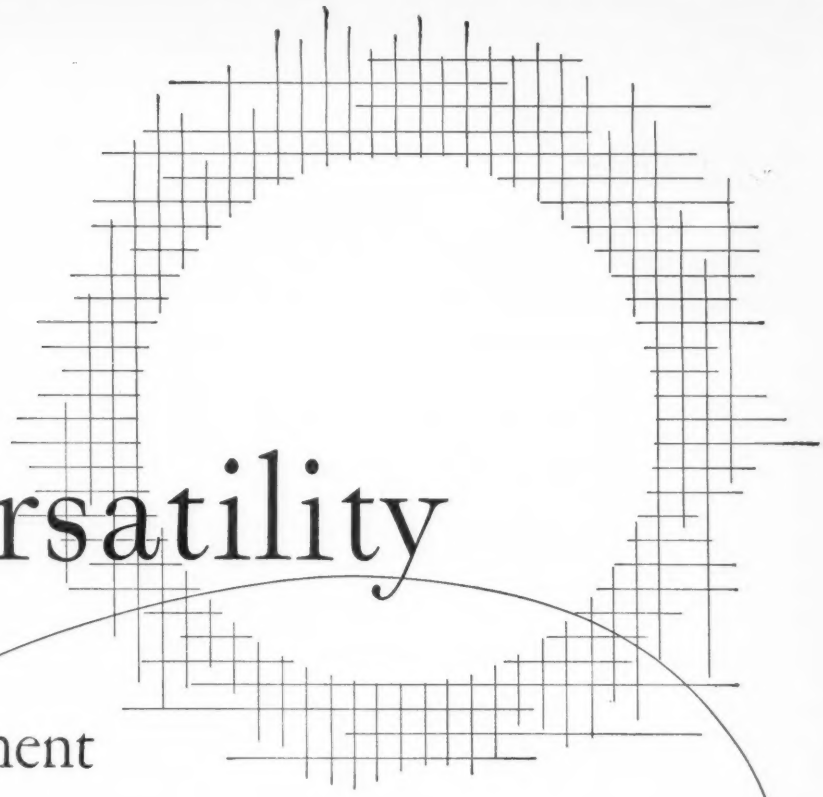
Beitrag zur Statik des Balkens von endlicher Breite (Statik plattenartiger Träger). I, II. H. Schürch. *Zeitschrift für angewandte Mathematik und Physik*, Vol. 2, Nos. 1, 2, January, March, 1951, pp. 26–34; 92–108; illus. 7 references. In German.

Contribution to the statics of a beam of finite width (plate-like structures), with application to the calculation of low-aspect-ratio wings on the basis of plate theory, taking into account variable local stiffness, anisotropic elastic behavior, and oblique and curved edges. **I.** Extension of plate theory to the sandwich plate; differential equation of the elastic surface; methods of solving the differential equation of deformation; statics of the simple beam; statics of the wide beam. **II.** Approximate solution with the aid of regular wing theory; transverse bending; extension of the deflection theory; calculated examples.

(*Continued on page 90*)



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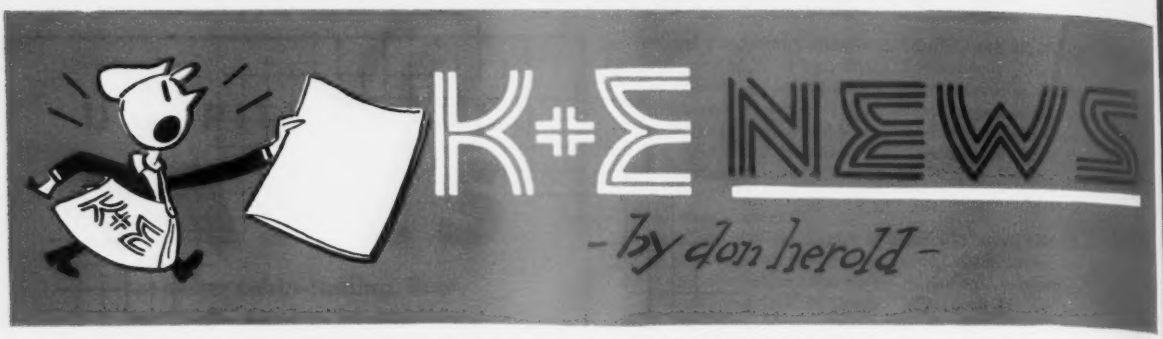

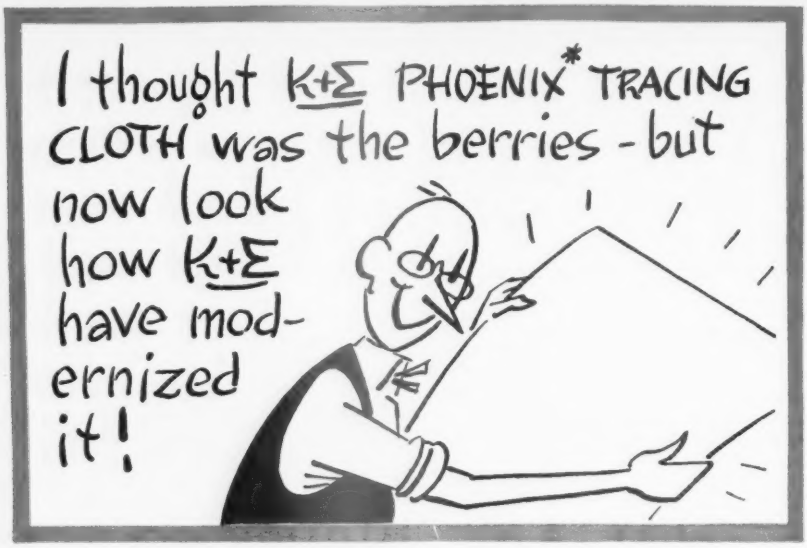

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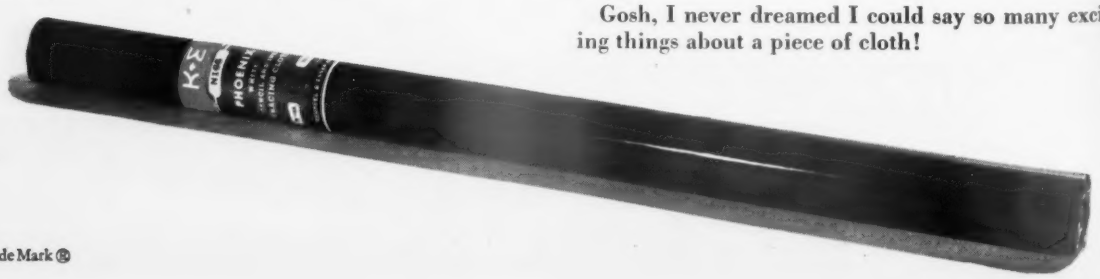

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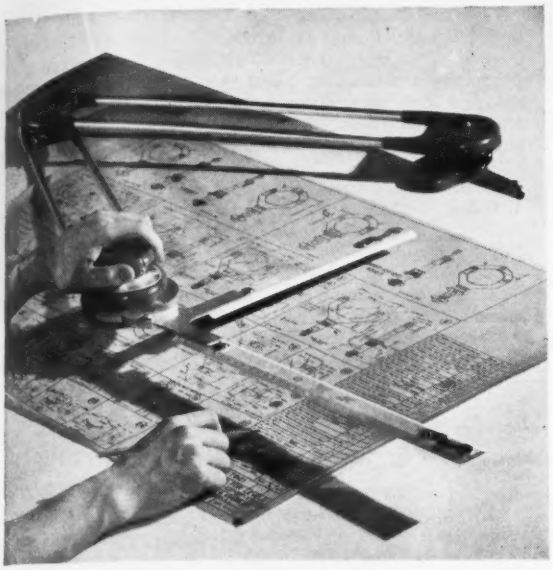

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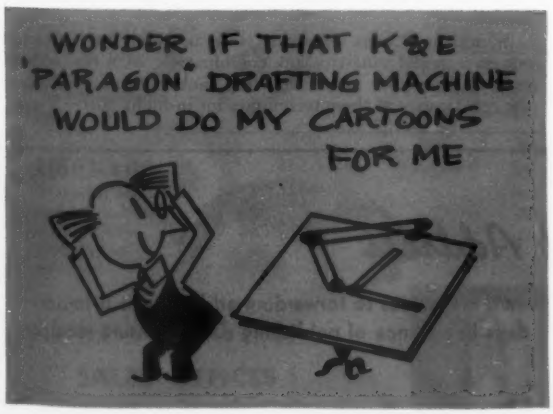

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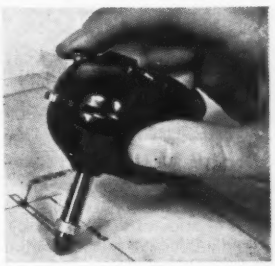

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erences. In German. Singular properties and construction of connecting curves of twin crank gear. These curves may be used to set up wing and turbine-blade contours.

Über die Wirksamkeit von Flügelendklappen. Nikolaus Rott. *Zeitschrift für angewandte Mathematik und Physik*, Vol. 2, No. 3, May, 1951, pp. 208–212, illus. 2 references. In German. Approximate calculation of aerodynamic forces on wing end-plate.

Full-Scale Investigation of the Maximum Lift and Flow Characteristics of an Airplane Having Approximately Triangular Plan Form. Herbert A. Wilson, Jr., and J. Calvin Lovell. *U.S., N.A.C.A., Research Memorandum No. L6K20*, February 12, 1947. 23 pp., illus. 7 references.

Aeroelasticity

A Third Order Boundary Value Problem Arising in Aeroelastic Wing Theory. George Seifert. *Quarterly of Applied Mathematics*, Vol. 9, No. 2, July, 1951, pp. 210–218. 4 references. Analysis of the boundary conditions in problems of chordwise divergence or sweptforward wing-bending divergence.

Single-Degree-of-Freedom-Flutter Calculations for a Wing in Subsonic Potential Flow and Comparison with an Experiment. Harry L. Runyan. *U.S., N.A.C.A., Technical Note No. 2396*, July, 1951. 27 pp., illus. 7 references.

Study of single-degree-of-freedom flutter associated with the pitching of an airfoil about various locations of the axis of rotation, including the effects of Mach Number (up to $M = 0.7$) and structural damping. Calculations, based on two-dimensional force coefficients, were compared with test results on an airfoil of aspect ratio 5.87 and at $M = 0.06$–0.3.

Problems in Aircraft Dynamic Response. James B. Rea. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 26–28, 88, 90, illus. 4 references.

Investigation of the Fatigue Strength of Full-Scale Airplane Wing Structures. Dwight O. Fearnow. *U.S., N.A.C.A., Research Memorandum No. L51D12a*, July 13, 1951. 30 pp., illus. 7 references. Instrumentation; test procedure and apparatus for fatigue-strength studies using the resonant-frequency method on full-scale C-46 airplane wings; analysis of test results.

Structural Damping with Complex Stiffness. H. R. Grummann and R. E. Newton. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 22, 70, 74–76, 78, 80, 84, illus. 4 references. Analysis of the transient motion of one-degree-of-freedom systems subjected to sinusoidal excitation; review of the solution for the system with viscous damping.

Vibrations of a Clamped Circular Plate Carrying Concentrated Mass. R. E. Roberson. *American Society of Mechanical Engineers, Applied Mechanics Division, West Coast National Conference, Stanford, Calif., June 22, 23, 1951, Paper No. 51–APM-5.* 4 pp., illus. 3 references.

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BODY GROUP

Design of Aircraft Loading Ramps. George H. Ikola. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 100–105, illus.

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DEVELOPMENT TESTING

Temperature Testing the B-36. R. C. Sebold. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 20, 21, 44, 46, 50, illus.

Problems involving equipment operation, brittleness of materials, rubber deterioration, and lubrication encountered in flights of the Convair B-36 in the low-temperature regions (approximately −100°F.) of the stratosphere.

LANDING GEAR

Evaluation of the Reduced-Mass Method of Representing Wing-Lift Effects in Free-Fall Drop Tests of Landing Gears. Benjamin Milwitzky and Dean C. Lindquist. *U.S., N.A.C.A., Technical Note No. 2400*, July, 1951. 43 pp., illus. 3 references.

The results of reduced-mass drop tests of landing gear are compared with data from simulated air-borne impacts and free-fall drop tests. Total dropping weight was 2,500 lbs.; vertical velocities at contact ranged from 3 to 12 ft. per sec.

Landing Gear: Shock Absorbers and Drop Testing. II—Drop Testing. John F. Ceccarelli. *Hydraulic Engineer*, Vol. 1, No. 2, June-July, 1951, pp. 4, 5, 8, illus. A typical drop-test setup for the main landing gear of an Air Force jet fighter; calculations.

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Aluminum-Alloy Hangar: A Three-Bay, 125-Ft. Clear-Span Structure at London Airport. *Aircraft Production*, Vol. 13, No. 153, July, 1951, pp. 227, 228, illus.

Simplified Hydrant Refueling Systems. Walter Palmer. *Esso Air World*, Vol. 3, No. 6, May-June, 1951, pp. 160, 161, illus.

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Physics and Psychophysics of Weightlessness. H. Haber and S. J. Gerathewohl. *Journal of Aviation Medicine*, Vol. 22, No. 3, June, 1951, pp. 180–189, illus. 6 references. Problems associated with the subgravity and zero-gravity states.

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Parallel Production of Altered Infectivity of a Streptococcus and Related Filterable Agents Isolated from Outdoor Air.

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Shear Strength: The shear strength of "K" Monel, as determined with .050-in. x .250-in. specimens subjected to double shear, is (full hard, age-hardened) 98,450 psi maximum, with 0.04 in. deflection. The shear strength of "K" Monel rivets, fully age-hardened, is 89,200 psi with ultimate tensile strength of 147,000 psi.

Spring Properties: "K" Monel wire can be cold-drawn and age-hardened to develop 160,000 to 200,000 psi tensile strength. The torsional proportional limit of cold-drawn, age-hardened wire is about 40% of the ultimate tensile strength.

Endurance Limit: In rotating beam tests of polished specimens at room temperature and 10,000 r.p.m., "K" Monel (cold-drawn, age-hardened) showed an endurance limit for 10^8 cycles of 41,000 to 59,000 psi.

Magnetic Characteristics: "K" and "KR" are non-magnetic under ordinary conditions and remain so at sub-zero temperatures.

Working Characteristics: Both "K" Monel and "KR" Monel may be hot-worked, forged, and cold-worked. "K" Monel may be readily machined in the annealed condition and may be considered commercially machinable at practical rates in other conditions with Brinell hardness of up to 275. "KR" Monel, because of higher carbon content and special thermal treatment, has better machinability than "K" Monel and is recommended for parts requiring more intricate machining. Because of greater hardness, both alloys will take a higher polish than Monel. Both may be joined by the usual welding, brazing, and soldering processes.

Corrosion Resistance: These alloys are highly resistant to attack by most commonly-encountered corrosives, including mineral and organic acids, alkalies, salts, potable and industrial waters, foods, organic compounds, and oxidizing atmospheres at normal and elevated temperatures.

Forms Produced: "K" Monel is supplied in most commonly-used mill forms—rods, hexagons, squares, flats, strip, sheet, seamless tubing, wire, welding materials—and in a variety of finishes and conditions. "KR" Monel is produced in rods, hexagons, squares, hot-rolled and cold-drawn.

Applications: Because these alloys retain their non-magnetic, corrosion-resistant, and high physical qualities at abnormal temperatures, they have been used to advantage in aviation instruments, roller chains for retractable landing gear, controls, springs and contact arms in electrical equipment, in stressed structural members and fastenings.

"K" MONEL
Effect of temperature on physical properties
(Age-hardened condition)

Test Temperature °F.	Yield Strength (0.20% offset) psi.	Tensile Strength psi.	Elongation in 2 in. per cent	Creep Strength (0.10% in 10,000 hr.) psi.	Hardness (Brinell)	Impact (Charpy) ft.-lb.
−300	160,200	202,000	27	...	...	...
−110	134,600	171,550	17.3	...	36 (Rock. C)	27
Room	111,000	160,000	23.5	...	331	27
200	108,000	150,000	23.5	...	...	...
400	103,000	149,000	24	...	...	...
600	105,000	146,000	23	...	...	...
750	...	...	...	67,000	...	...
800	105,000	124,000	8.5	48,000	302	...
1000	92,000	95,000	3	8,500	255	...
1100	...	...	...	...	229	...
1200	80,000	80,000	1.5	...	...	...
1400	30,000	45,000	8	...	...	...

FURTHER DATA AVAILABLE

A 23-page reference manual, *Engineering Properties of "K" Monel and "KR" Monel,* contains all essential engineering information on these alloys. It is available, free, for your files.

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Edward C. Rosenow. *Journal of Aviation Medicine*, Vol. 22, No. 3, June, 1951, pp. 225–234, illus. 24 references.

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Link Thrives on Simulator Boom. George L. Christian. *Aviation Week*, Vol. 55, No. 2, July 9, 1951, pp. 43, 44, 47, 48, illus.

Flight trainers and simulators developed by Link Aviation Corp. for military and air-line uses; an electronic recording and sensing system that is used in flight to study pilot performance; gunnery trainers.

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Training by Television; The Comparative Effectiveness of Instruction by Television, Television Recordings, and Conventional Classroom Procedures (Rapid Mass Learning). Robert T. Rock, Jr., James S. Duva, and John E. Murray. (Fordham University.) *U.S., Office of Naval Research, Special Devices Center, Report No. 476-0202 (NAVEXOS P-850-2)*, 1951. 24 pp., illus.

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COMMUNICATIONS

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Microwave Components: Precision Casting vs. Electroforming. A. A. Feldmann. *Materials & Methods*, Vol. 34, No. 1, July, 1951, pp. 70–72, illus. 4 references. Evaluation of new manufacturing techniques used in making wave-guide components; accuracies available.

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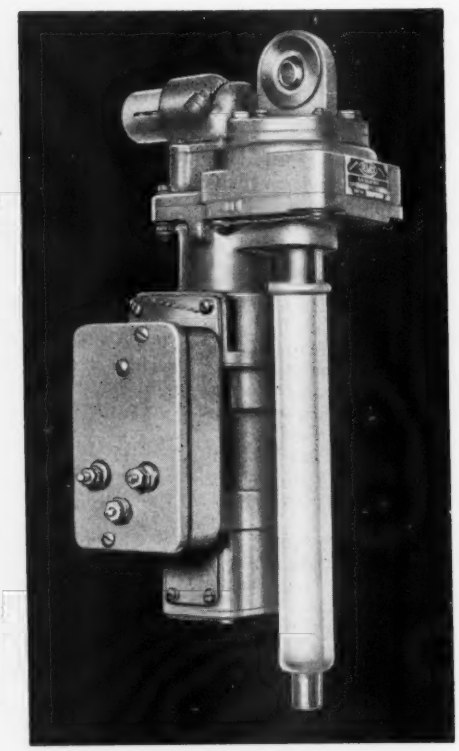

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veillance program on the ENIAC; tube replacement, tests, standards, and recording of tube histories.

Die Laufzeit, Elektronenbahnen, Kathodenfeldstärke und Potential der Raumladungsdiode für jede Anfangsgeschwindigkeit, Anfangsrichtung und Strom. Asim O. Barut. *Zeitschrift für angewandte Mathematik und Physik*, Vol. 2, No. 1, January, 1951, pp. 35–42, illus. 9 references. In German. Transition time, electron paths, cathode field strengths, and potential of the space-charge diode for each initial velocity, initial direction, and current.

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The Influence of Mutual and Self Inductance on the Accurate Determination of Capacities. A. Michels and C. A. Ten Seldam. *Applied Scientific Research, Section B, Electrophysics, Acoustics, Optics, Mathematical Methods*, Vol. B 2, No. 2, 1951, pp. 73–76, illus.

Precision Calibrator for L.F. Phase-Meters. M. F. Wintle. *Wireless Engineer*, Vol. 28, No. 334, July, 1951, pp. 197–205, illus. 10 references.

Design details and operation of an accurate calibrator that does not require a reference standard. The calibrator provides two outputs at the required frequency. The phase of one output is fixed. The phase shifter on the channel producing the other output is calibrated to give a specific phase difference between the outputs. Circuit diagrams show the components, and their functions are explained.

A Note on a Bridged-T Network. Peter G. Sulzer. *Institute of Radio Engineers, Proceedings*, Vol. 39, No. 7, July, 1951, pp. 819–821, illus. 4 references. Application in a dual-feedback R-C sinusoidal oscillator.

Practical Methods of Waveform Analysis. J. B. McMillan. *Electronic Engineering*, Vol. 23, No. 281, July, 1951, pp. 250–252, illus. Design and operation, including block and circuit diagrams, of the Messrs. Dawe Instruments, Ltd. Wave Analyser, Type 705.

UHF Power Measurements. Engineering Department, Aerovox Corp. *Aerovox Research Worker*, Vol. 21, No. 5, May, 1951, pp. 1–3, illus.

Experimental Testing of Electrical Networks by Means of the Unit Function Response. J. van Slooten. *Philips Technical Review*, Vol. 12, No. 8, February, 1951, pp. 233–239, illus. 2 references.

Design of an instrument by which the response of an impedance or a network to a current in the form of a unit function is traced on the screen of a cathode-ray tube. Circuit diagrams show the multivibrator that furnishes the unit function and the oscilloscope. Applications explained include investigations of a resistance, resistance and capacitance in parallel, resistance and self-inductance in parallel, L-C circuits, and band-pass and low-pass filters.

An Instrument for Recording the Frequency Drift of an Oscillator. W. W. Boelens. *Philips Technical Review*, Vol. 12, No. 7, January, 1951, pp. 193–199, illus. 1 reference.

Design of a recording drift meter that automatically plots the drift curve. The meter was designed for testing FM radio receivers of an effective frequency range of 88–108 mc. The meter records the absolute value of the difference between a standard frequency and the oscillator frequency. A block diagram of the complete apparatus and circuit diagrams of the individual components are given.

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Correspondence: Experimental Results of Continuous-Wave Navigation Systems. Fred S. Howell. *Institute of Radio Engineers, Proceedings*, Vol. 39, No. 7, July, 1951, p. 841. 4 references.

NOISE & INTERFERENCE

The Distribution of Energy in Randomly Modulated Waves. David Middleton. *Philosophical Magazine*, Vol. 42 (7th Series), No. 330, July, 1951, pp. 689–707, illus. 14 references. Analysis of a carrier phase- or frequency-modulated by noise, and of a carrier amplitude-modulated by noise; presentation of theory and measurements from recent research.

Direct-Reading Noise-Factor Measuring Systems. R. W. Peter. *RCA Review*, Vol. 12, No. 2, June, 1951, pp. 269–281, illus. 8 references.

Methods to Extend the Frequency Range of Untuned Diode Noise Generators. Harwick Johnson. *RCA Review*, Vol. 12, No. 2, June, 1951, pp. 251–257, illus. 1 reference.

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A Measuring Arrangement for Waveguides. A. E. Pannenborg. *Philips Technical Review*, Vol. 12, No. 1, July, 1950, pp. 15–24, illus. 9 references.

Brief review of the propagation of waves in waveguides and of the occurrence of standing waves; design and operation of a probe to measure wave-guide reflections, for waves with a length between 1 mm. and 30 cm.

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Determination of Electron Densities in the Ionosphere from Experimental (h', f) Curves. H. A. Whale. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 4, 1951, pp. 244–253, illus. 10 references.

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Über die Dämpfung der ausserordentlichen Komponente in der E_1-Schicht der Ionosphäre. Walter Becker. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 2, 1950, pp. 37–81, illus. 4 references. In German. The absorption of extraordinary components in the E_1-layer of the ionosphere.

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Studies of the F_2 Layer in the Ionosphere. I—The Position of the Ionospheric Equator in the F_2 Layer. Edward Appelton. *Journal of Atmospheric and Terrestrial Physics*, Vol. 1, No. 2, 1950, pp. 106–113, illus. 5 references.

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Correspondence: The Permittivity of Air at a Wavelength of Ten Centimeters. J. V. Hughes and W. Lavrench. *Institute of Radio Engineers, Proceedings*, Vol. 39, No. 7, July, 1951, p. 839, illus. 1 reference.

Remarks Concerning Wave Propagation in Stratified Media. S. A. Schelkunoff. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 117–128, illus. 3 references.

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Extension of Weyl's Integral for Harmonic Spherical Waves to Arbitrary Wave Shapes. H. Poritsky. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 33–42, illus.

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Diffraction and Reflection of Pulses by Wedges and Corners. Joseph B. Keller and Albert Blank. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 75–94, illus. 5 references.

Vector Wave Functions. R. D. Spence and C. P. Wells. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 95–104, illus. 4 references.

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Equipment

ELECTRIC (16)

Power Leads for Fractional Hp Motors. A. L. Ulmer. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 135–138, illus.

HYDRAULIC & PNEUMATIC (20)

Aircraft Boost Valve Characteristics. J. C. Monroe. *Applied Hydraulics*, Vol. 4, No. 7, July, 1951, pp. 50–52, illus. Valve characteristics of a closed center system; static and dynamic calibration methods; problems caused by entrapped air.

Synchronizing Piston Movement in Hydraulic Cylinders. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 156, 157, illus.

Sketches of seven circuits which show methods of causing two or more hydraulically operated pistons to extend and retract in perfect synchronism; factors that can upset the synchronism.

Designing an Integral Dashpot for a Hydraulic Cylinder. William E. Soong. *Machine Design*, Vol. 23, No. 7, July, 1951, pp.129–132, 198, illus.

The impact at end of stroke is absorbed by controlled flow through radial metering-pin orifices; the design uses a straight hollow pin with radially drilled orifices rather than a tapered pin. Test results show close agreement with design conditions.

The Hydraulic Fluid That Will Not Burn. George L. Christian. *Aviation Week*, Vol. 55, No. 3, July 16, 1951, pp. 54, 57, 58, 61, illus. Properties of nonflammable H-2 hydraulic fluid, developed by R. M. Hollingshead Corp.

Flight Operating Problems (31)

ICE PREVENTION & REMOVAL

A Simplified Instrument for Recording and Indicating Frequency and Intensity of Icing Conditions Encountered in Flight. Porter J. Perkins, Stuart McCullough, and Ralph D. Lewis. *U.S., N.A.C.A., Research Memorandum No. E51E16*, July 3, 1951. 26 pp., illus. 3 references. Design, and operation for accumulating data on the occurrence, extent, and severity of icing conditions on routine air-line operations.

Further Remarks on Intermittent Heating for Aircraft Ice Protection. Frederick Weiner. *American Society of Mechanical Engineers, Semi-Annual Meeting, Toronto, June 11–14, 1951, Paper No. 51-SA-38.* 12 pp., illus. 7 references.

Solution of the equation for intermittent heat transfer of an internally-heated propeller during icing conditions by an electric analog method; comparison with measured time-temperature data.

An Investigation of a Rotor Blade Thermal Ice-Prevention System for the H-5 Helicopter (Sikorsky). E. F. Katzenberger. *Aeronautical Engineering Review*, Vol. 10, No. 9, September, 1951, pp. 25–33, illus. 8 references.

Flight Safety & Rescue (15)

Considerations in the Design and Installation of Cockpit Check Lists, Placards, and Manuals. David H. Kaplan. **Introduction—Check Lists: "You Can't Remember All You Know."** Jerome Lederer. *Aeronautical Engineering Review*, Vol. 10, No. 9, September, 1951, pp. 10–16, illus. 14 references. Basic design arrangements of check lists; lighting; style of lettering; location in cockpit.

"Seeing Eye" Used to Detect Aircraft Fires. *U.S., Central Air Documents Office (Army-Navy-Air Force), Technical Data Digest*, Vol. 16, No. 7, July, 1951, pp. 2, 3, illus.

A photoelectric fire detector uses a lead sulfide cell that is sensitive to infrared radiation emitted by a flame. The system consists of an amplifier, 9 infrared sensitive detector units, and a test switch assembly. The system responds to infrared intensity variation between 5 and 25 cycles per sec.

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Fuel–Air Ratio and Intake Air Temperature Control Equipment for Use on Single Cylinder Test Engines. *The Texas Company, Beacon Laboratories, Report No. 503-70E*, April 30, 1951. 31 pp., illus. Data on the construction of a fuel–air ratio controller and a quick-change intake air-temperature controller and summary of operating experience with the units.

Viscosity and Density of Lubricating Oils from 0 to 150,000 Psig and 32 to 425°F. Donald Bradbury, Melvin Mark, and R. V. Kleinschmidt. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 667–672, Discussion, pp. 672–676, illus. 12 references. Summary of research on viscosity of 46 lubricants; apparatus and test methods; typical data.

Gliders (35)

Der Moswey 4a. René Comte. *Schweizer Aero-Revue*, Vol. 26, No. 6, June, 1951, pp. 269, 270, illus. In German.

Guided Missiles (1)

Evolution of the Guided Missile. III—Problems of the Heavyweight Supersonic Rocket; The German A-9/A-10 Projects. Kenneth W. Gatland. *Flight*, Vol. 59, No. 2214, June 29, 1951, pp. 768–770, illus.

Instruments (9)

An Instrument for Automatically Recording Waviness of Surfaces. C. W. Medhurst. *Journal of Scientific Instruments*, Vol. 28, No. 7, July, 1951, pp. 211–214, illus.

Theory, design, and operation of an instrument that automatically and rapidly records the waviness of surfaces on graph paper. It is suitable for production testing. The instrument is used for tests on aircraft wings and wing panel blocks but can be used to study the waviness of any surface.

Control-Surface Position Feedback in Flight-Control Systems. Leonard Becker. *Aeronautical Engineering Review*, Vol. 10, No. 9, September, 1951, pp. 17–19, 33, illus. 1 reference. Brief review and outline of the characteristics and effects of the use of constant negative control-surface feedback.

Bench-Test Investigation of the Transient-Response Characteristics of Several Simulated Airplanes Incorporating an Autopilot Sensitive to Yawing Accelerations. Donald A. Howard. *U.S., N.A.C.A., Technical Note No. 2395*, July, 1951, 27 pp., illus. 4 references.

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Nondimensional study of the problem of a speed governor of a rotating disc in the presence of viscous damping. The transient response of the system was obtained with an analog computer;

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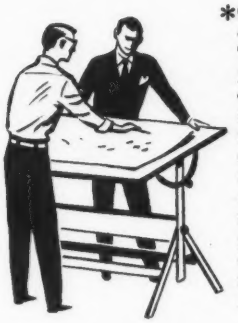

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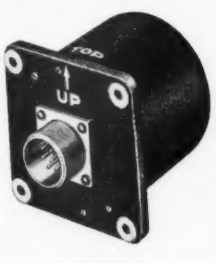

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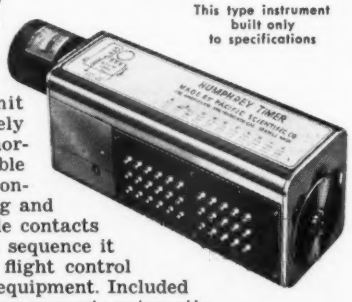

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the results are presented as families of curves in nondimensional form.

On the Regulation of Industrial Processes. H. J. Roosdorp. *Philips Technical Review*, Vol. 12, No. 8, February, 1951, pp. 221–227, illus.

General outline of regulating systems that are closed circuits with automatic controllers; accuracy and dynamic stability of such systems; analysis of an electric model of the regulator.

Graphical Synthesis of Networks for A-C Servos. G. A. Bjornson. *Electrical Engineering*, Vol. 70, No. 7, July, 1951, pp. 571, illus.

Fundamental Studies in Servomechanisms Rated Approximately 100 Watts. *Massachusetts Institute of Technology, Servomechanisms Laboratory, Project No. 6097, Report*, Vols. I, II, September, 1943. 100 pp., illus. 11 references.

General survey of the servomechanism problem, development of a hydraulic and of an all-electric servomechanism, both for application to an automatic fuse setter.

Magnetic Particle and Hysteresis Clutches for Servo Systems. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 176, 177, illus. Advantages, and data on the performance characteristics and dimensions of various models of the Duncan & Bayley magnetic-particle and hysteresis-type clutches.

Optimum Gear Train Ratios for Instrument Servomechanisms. L. N. Canick. *Product Engineering*, Vol. 7, No. 7, July, 1951, pp. 108, 109, illus. Method for determining the optimum gear reduction ratio of a step train; procedure for designing a gear train of minimum inertia.

Calibration of Precision Dynamometers by Means of a Pressure Balance. H. B. Bouwan, A. Visser, D. A. Beekhuis, and F. H. Toneman. (*De Ingenieur*, Vol. 53, No. 6, February 9, 1951, pp. O1–O4.) *The Engineers' Digest*, Vol. 12, No. 6, June, 1951, pp. 183–185, illus. 5 references.

Calibration apparatus consists of a hydraulic press that is coupled to a high-pressure pump and a pressure balance. Operation is demonstrated by calibrating a loop dynamometer of the Wazau type.

An Investigation of a Method to Indicate Atmospheric Turbulence from an Airplane in Flight. H. B. Tolefson and C. A. Gurtler. *U.S., N.A.C.A., Research Memorandum No. L50K28a*, July 9, 1951. 18 pp., illus. 4 references.

Operation, and analysis of test data of an instrument to indicate air turbulence from an airplane in flight. Rapid fluctuations in air speed in gusty air are used to measure the turbulence.

A Simplified Instrument for Recording and Indicating Frequency and Intensity of Icing Conditions Encountered in Flight. Porter J. Perkins, Stuart McCullough, and Ralph D. Lewis. *U.S., N.A.C.A., Research Memorandum No. E51E16*, July 3, 1951. 26 pp., illus. 3 references.

Design, calibration, and operating characteristics. The instrument consists of an ice-collecting unit, a film-recorder unit, and a remote-indicator panel. It operates on differential pressure created when small total-pressure holes in a static-pressure vented system are allowed to plug with ice accretions.

Study of Linear-Resistance Flowmeters. F. W. Fleming and R. C. Binder. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 621–624, illus. 2 references.

Experimental study of the characteristics of linear-resistance flowmeters. Tests were made with pipes having inside diameters of 1.873, 1.383, 0.872, and 0.502 in., using cotton and steel wool as the resistance materials. Characteristic curves show test results.

A Compensated Thermal Anemometer and Flowmeter. C. E. Hastings and C. R. Wcislo. *Electrical Engineering*, Vol. 70, No. 7, July, 1951, p. 597, illus.

A sensitive, accurate thermal anemometer that is almost independent of temperature operates from a heated noble thermopile placed in the air stream. Instruments of this type can measure flow velocities as low as 5 ft. per min. and up to 400 miles per hour.

Discharge Coefficients of Small-Diameter Orifices and Flow Nozzles. H. P. Grace and C. E. Lapple. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 639–647, illus. 4 references.

Discharge coefficients were determined in a standard 1-in. pipe for thick-plate and knife-edge orifices of $^1/_{32}$-in. to $^3/_4$-in. diameter and for critical (sonic) flow nozzles of $^1/_{32}$-in. to $^1/_4$-in. diameter. Details are given of calibration procedures and precision of measurement.

The Electrical Recording of Diagrams with a Calibrated System of Coordinates. B. G. Dammers, P. D. van der Knaap, and A. G. W. Uitjens. *Philips Technical Review*, Vol. 12, No. 10, April, 1951, pp. 283–292, illus. 8 references.

Theory, operation, and components of an instrument in which a lattice-type form of calibrated coordinate system is produced on the oscilloscope screen simultaneously with the tracing of the diagram, giving a means of accurate numerical interpretation of the curves.

A Versatile Bridge System for Use with Wire Resistance Gauges in the Measurement of Slow Transient Strains. M. J. Richard. *Electronic Engineering*, Vol. 23, No. 281, July, 1951, p. 276, illus.

Temperature-Sensing Devices for Jet Engines. Andrew I. Dahl and Ernest F. Fiock. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 23, 94, 95, illus.

Design of an apparatus devoted by the National Bureau of Standards for measuring the response of jet-engine temperature elements under conditions approximating a jet-engine combustion temperature. Cutaway drawings show the entire apparatus and the shielding for the test instrument.

Laws & Regulations (44)

High Altitude Flight and National Sovereignty. John C. Cooper. (*Address delivered before the Escuela Libre de Derecho, Mexico City*, January 5, 1951.) *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 46–50.

International Airmail; A Review of Past Accomplishments and the Future Program of Discussion Between Airlines and Postal Administrations. René Briend. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 34–42.

U.S. Regulation and the C.A.B.; The Position of the Civil Aeronautics Board in American Government Tradition and Structure. Delos Wilson Rentzel. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 21–31, illus.

"This Freedom." Frederick Tymms. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 16–20.

Freedom of air as defined at the Chicago International Conference on Civil Aviation (1944); characteristics of a scheduled air service; need for a common standard for distinguishing between scheduled air services and nonscheduled operations.

Facilitation Prospects; Some Projects by Which IATA's FAL Organization Hopes To Speed Up International Airline Traffic. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 54–70.

IATA Clearing House—1950. Arthur J. Quin-Harkin. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 84–86, illus.

Operating Statistics of IATA Members for 1949. *International Air Transport Association, Bulletin*, No. 13, June, 1951, pp. 87–93.

Machine Elements (14)

Machine Design Data Sheet: Design Factors for Stress Concentration. V—Transverse Holes in Bars and Shafts. R. E. Peterson. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 155–159, illus. 15 references.

Designing for Economical Gasketing. E. C. Frazier. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 139–144, illus. Tables and cutaway drawings show the properties and uses of gasket materials and design suggestions for gasketed joints.

BEARINGS

Performance of Oil-Film Bearings with Abrasive-Containing Lubricant. A. E. Roach. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 677–686, illus. 10 references.

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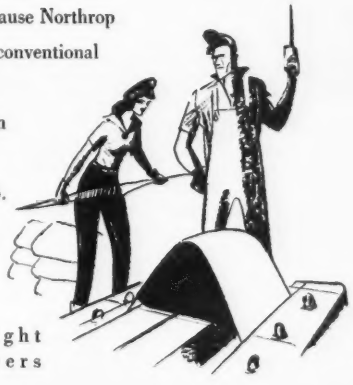

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Experimental study of embedability, effects of abrasive concentration, abrasive-particle size, gridding, oil grooves, copper-lead composition; comparison of the performance of bearing materials; results of tests using the method.

FASTENINGS

Characteristics of Temproof Mountings. Gordon H. Waite and Bruce W. Campbell. *Lord Manufacturing Company, Report No. 242*, March 6, 1951. 10 pp., illus., folding charts. Design specifications and characteristics, test procedure and results, and evaluation of a flexible mounting for base-mounted air-borne equipment.

FRICTION

Determination of the Dynamic Coefficient of Friction for Transient Conditions. G. G. Gould. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 649–654, illus.

Dry friction studies at constant ambient temperature and humidity in which tangential and normal frictional forces were measured as functions of time. Curves show the behavior of the frictional forces under transient conditions for different combinations of friction materials and mating surfaces.

GEARS & CAMS

The Effect of Oil Viscosity on the Power-Transmitting Capacity of Spur Gears. V. N. Borsoff, J. B. Accinelli, and A. G. Cattaneo. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 687–694, Discussion, pp. 694–696, illus. 7 references.

Analysis based on tests made on spur gears with nine lubricants of various viscosities of the Lewis gear design equation, incorporating the lubricant viscosity into the equation. The gear-testing equipment and test procedure are explained.

Shotpeening As a Factor in the Design of Gears. John C. Straub. *Mechanical Engineering*, Vol. 73, No. 7, July, 1951, pp. 565–569, illus. 7 references.

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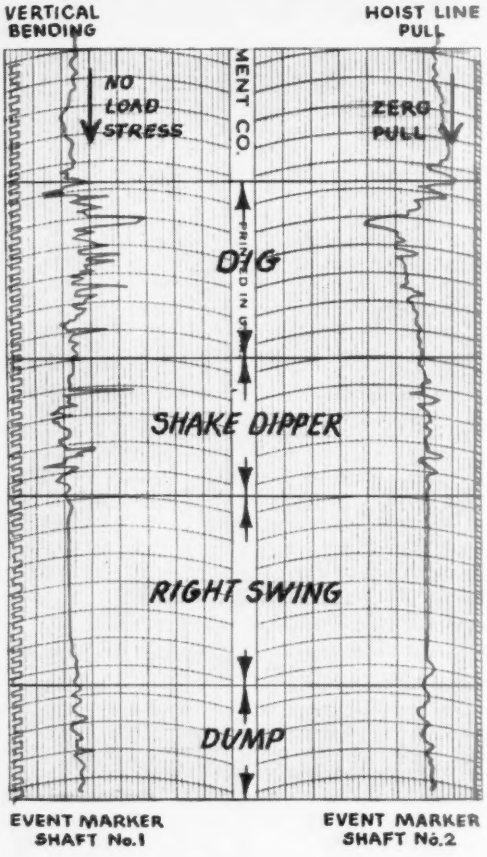

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Something New in Helicopters. *The Aeroplane*, Vol. 80, No. 2084, June 29, 1951, p. 806, cutaway drawings. Rotor hub, power plant, and control system of the Aero Sud-Ouest Ariel II helicopter, powered by a 220-hp. Turboméca Artouste gas turbine.

Sciences, General (33)

MATHEMATICS

A Signed Binary Multiplication Technique. Andrew D. Booth. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 236–240. 3 references. A technique by which binary numbers of either sign may be multiplied together by a uniform process that is independent of any foreknowledge of the signs of these numbers.

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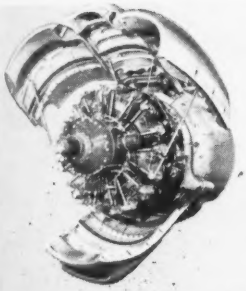

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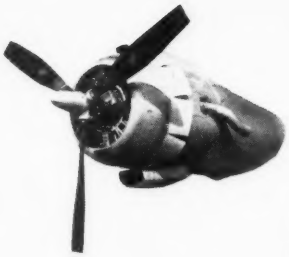

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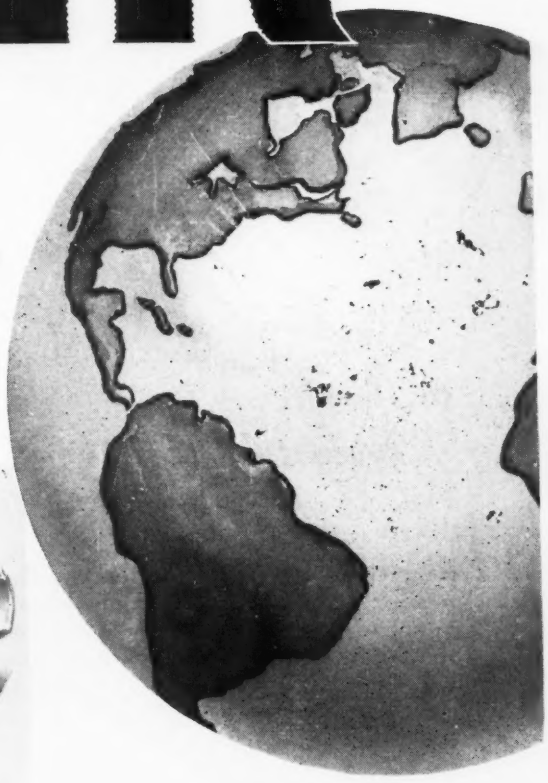

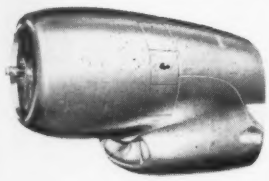

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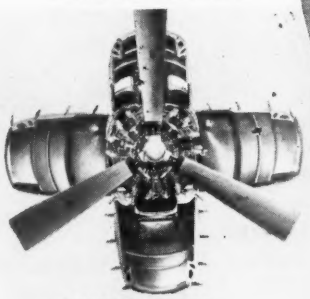

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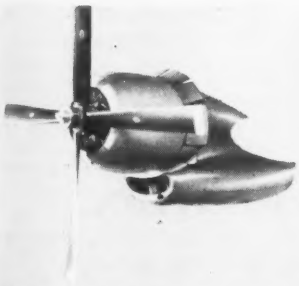

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Programmgesteuerte digitale Rechengeräte (elektronische Rechenmaschinen). III, IV. Heinz Rutishauser, Ambros Speiser, and Eduard Stiefel. *Zeitschrift für angewandte Mathematik und Physik*, Vol. 2, Nos. 1, 2, January, March, 1951, pp. 1–25; 63–92, illus. 1 reference. In German. Program-controlled electronic digital computers.

Some Aspects of Electrical Computing. II. J. Bell. *Electronic Engineering*, Vol. 23, No. 281, July, 1951, pp. 264–269, illus. Electric setups for various computing processes.

The Electro-Analogue, an Apparatus for Studying Regulating Systems. I—Components and Functions. II—The Electrical Execution. J. M. L. Janssen and L. Ensing. *Philips Technical Review*, Vol. 12, Nos. 9, 11, March, May, 1951, pp. 257–271; 319–335; illus. 13 references.

Almost Periodicity and Non-Absolutely Integrable Functions. H. Burkill. *London Mathematical Society, Proceedings*, Vol. 53 (Series 2), Part 1, January 22, 1951, pp. 32–42. 4 references. Extension of the concept of almost periodicity to functions integrable in the general Denjoy sense and to the summability of their Fourier series.

Eigenfunction Expansions Associated with Partial Differential Equations. E. C. Titchmarsh. *London Mathematical Society, Proceedings*, Vol. 1 (Series 3), No. 1, March, 1951, pp. 1–27. 9 references.

Expansion of an arbitrary function in terms of the solutions of the partial differential equation

$$\nabla^2\phi + [\lambda - q(x, y)]\phi = 0$$

considering the whole (x, y) plane. A theory is developed for the bounded region, assuming the region to be a square, and extended to the whole (x, y) plane. Fourier and iterative processes are used.

Solution of Some Partial Differential Equations (with Tables). Louis Weinberg. *Franklin Institute, Journal*, Vol. 252, No. 1, July, 1951, pp. 43–62. 4 references.

Tables of solutions are presented for the Helmholtz and Laplace equations for rectangular, circular cylinder, elliptic cylinder, parabolic cylinder, spherical, prolate spheroidal, oblate spheroidal, and parabolic coordinate solutions. It is shown that Laplace's equation, Poisson's equation, and the diffusion, wave, and damped-wave equations are special cases of the Helmholtz equation.

The Application of Relaxation Methods to the Solution of Non-Elliptic Partial Differential Equations. I—The Heat-Conduction Equation. D. N. de G. Allen and R. T. Severn. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 209–222, illus. 3 references.

The Application of Relaxation Methods to the Solution of Differential Equations in Three Dimensions. I—Boundary Value Potential Problems. D. N. de G. Allen and S. C. R. Dennis. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 199–208, illus., fold. chart. 3 references.

Tables of Two Integrals and of Spielrein's Inductance Function. Alan Fletcher. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 223–235. 12 references.

Tables for $\alpha = 0(.01)1$ of

$$I = \int_\alpha^1 (K - E)dk \text{ and } J = \int_\alpha^1 (K - e)k^{-3}dk$$

where K and E are complete elliptic integrals of the first and second kinds with modulus k, and of Spielrein's inductance function, $f(\alpha) = 16\pi/[3(1 - \alpha)^2](I - \alpha^3 J)$.

Transformations of Basic Hypergeometric Functions of Special Type. D. B. Sears. *London Mathematical Society, Proceedings*, Vol. 52 (Series 2), Part 6, April 28, 1949, pp. 467–483. 8 references.

Minimal Problems in Airplane Performance. Boris Garfinkel. *Quarterly of Applied Mathematics*, Vol. 9, No. 2, July, 1951, pp. 149–162. 2 references.

Development of the theory of operating an airplane to minimize an arbitrary function of the end-values of the generalized coordinates. Using the Calculus of Variations, the Euler-Lagrange equations are derived from the physical laws governing the motion of an airplane, considering a propeller-driven aircraft as a particle in equilibrium. Integrating the equations leads to a two-parameter family of curves which represents all solutions of all possible problems under consideration.

Boundaries for the Limit Cycle of Van der Pol's Equation. R. Gomory and D. E. Richmond. *Quarterly of Applied Mathematics*, Vol. 9, No. 2, July, 1951, pp. 205–209, illus. 1 reference.

Integrals and Trigonometric Series. J. C. Burkill. *London Mathematical Society, Proceedings*, Vol. 1 (Series 3), No. 1, March, 1951, pp. 46–57. 9 references.

On Diffusion by Discontinuous Movements, and on the Telegraph Equation. S. Goldstein. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 129–156, illus. 9 references.

Note on Iterations with Convergence of Higher Degree. Haskell B. Curry. *Quarterly of Applied Mathematics*, Vol. 9, No. 2, July, 1951, pp. 204, 205. 1 reference.

A Method of Gradients for the Calculation of the Characteristic Roots and Vectors of a Real Symmetric Matrix. Magnus R. Hestenes and William Karush. *U.S., National Bureau of Standards, Journal of Research*, Vol. 47, No. 1, July, 1951, pp. 45–61, illus. 4 references. Also available as *Research Paper No. 2227*. Superintendent of Documents, Washington. $0.20.

Inverses and Zero Divisors in Matrix Rings. J. C. Shepherdson. *London Mathematical Society, Proceedings*, Vol. 1 (Series 3), No. 1, March, 1951, pp. 71–85. 10 references.

On the Conformal Theory of Curves in a General Differential Metric Space. R. S. Clark. *London Mathematical Society, Proceedings*, Vol. 1 (Series 3), No. 1, March, 1951, pp. 58–70. 5 references.

On Minimal Surfaces with Partially Free Boundary. Hans Lewy. *Communications on Pure and Applied Mathematics*, Vol. 4, No. 1, June, 1951, pp. 1–13. 3 references.

The Calculation of the Coefficients of Certain Asymptotic Series by Means of Linear Recurrent Relations. H. A. Lauwerier. *Applied Scientific Research, Section B, Electrophysics, Acoustics, Optics, Mathematical Methods*, Vol. B2, No. 2, 1951, pp. 77–84. 2 references.

Space Travel

Ein streng lösbarer Fall des Dreikörper-Problems. Werner Schaub. *Weltraumfahrt*, No. 3, June, 1951, pp. 61–66, illus. In German. A rigid solution of a three-body problem, previously treated by Lagrange, in which the bodies are located at the angles of an equilateral triangle.

Structures (7)

Three-Dimensional Photoelasticity. R. C. O'Rourke. *Journal of Applied Physics*, Vol. 22, No. 7, July, 1951, pp. 872–878, illus. 8 references.

Derivation of a variational form of the Maxwell-Neumann law of photoelasticity and of a generalized Hamilton-Jacobi partial differential equation for the phases of the two waves that can propagate with finite velocity in weakly anisotropic and inhomogeneous media. The general problem, in which the principal stress directions in the plane of the wave front rotate arbitrarily as the latter propagates through the medium, is analyzed by the Sommerfeld-Runge method.

Mechanical Vibrator Adjusts Output Force While Running. *Product Engineering*, Vol. 22, No. 7, July, 1951, pp. 120, 121, illus.

The mechanical vibration exciter, used at The Glenn L. Martin Co., for investigating the vibratory characteristics of aircraft components. Two counter-rotating horseshoe weights move toward and away from their axes of rotation; this varies the force while they are in motion. The output force can be changed without stopping the machine, and any preset value of force can be held automatically over the entire speed range by an electrically-controlled servo system.

The Influence of Compressibility in Elastic-Plastic Bending. J. W. Craggs. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 241–247, illus. 2 references. Flexure of a uniform beam; investigation of the validity of assuming the material to be incompressible—i.e., assuming that all the stress components, except longitudinal tension or compression, are zero.

Graphical Integration. W. L. Vaughn. *Aero Digest*, Vol. 63, No. 1, July, 1951, pp. 29, 108, illus.

A graphical method of integration of loading curves to obtain shears, moments, and deflections of cantilever beams. The method is easy to apply, involves only two triangles, and gives slide-rule accuracy.

On the Inextensional Theory of Deformation of a Right Circular Cylindrical Shell. R. M. Hermes. *American Society of Mechanical Engineers, Applied Mechanics Division, West Coast*

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National Conference, Stanford, Calif., June 22, 23, 1951, Paper No. 51–APM-2. 4 pp., illus. 7 references.

Evaluation of solutions obtained according to the theory of inextensional bending of cylinders by comparing solutions calculated by the superposition method with experimental results.

On Combined Bending and Twisting of Thin Tubes in the Plastic Range. R. Hill and M. P. L. Siebel. *Philosophical Magazine*, Vol. 42 (7th Series), No. 330, July, 1951, pp. 722–733, illus. 2 references.

Calculation of the angles of bend and twist, the warping of the cross-section, and the instantaneous distribution of stress in a thin-walled circular tube under monotonic loading.

The Moving Griffith Crack. Elizabeth H. Yoffe. *Philosophical Magazine*, Vol. 42 (7th Series), No. 330, July, 1951, pp. 739–750, illus. 6 references.

Calculation of the stresses near the head of a rapidly propagating crack in a plate of isotropic elastic material assuming that the crack has a constant length. The problem reduces to that of a disturbance at constant speed and form in a plate in uniform tension. The solution is obtained from a system of elastic waves which represents the disturbance.

A General Method of Calculating the $M\epsilon_{max.}$ Diagram in Plastic Bending of Beams. Aris Phillips. *American Society of Mechanical Engineers, Applied Mechanics Division, West Coast National Conference, Stanford, Calif., June 22, 23, 1951, Paper No. 51–APM-6.* 6 pp., illus. 13 references. Equations and graphic construction for obtaining the $M\epsilon_{max.}$ curve for symmetric bending of bars in plasticity.

Discussion of "Die Grundlagen der mathematischen Plastizitätstheorie und der Versuch" (Basis of the Mathematical Theory of Plasticity and Experiment), by F. Stüssi. Author's Reply. P. P. Bijlaard. *Zeitschrift für angewandte Mathematik und Physik*, Vol. 2, No. 2, March, 1951, pp. 114–119, illus. 11 references. In German.

Charts Giving Critical Compressive Stress of Continuous Flat Sheet Divided into Parallelogram-Shaped Panels. Roger A. Anderson. *U.S., N.A.C.A., Technical Note No. 2392*, July, 1951. 31 pp., illus. 3 references. Charts give theoretical buckling-stress coefficients as functions of panel skewness and aspect ratio for sheet panels of a shape occurring in swept-wing plan forms.

Bending of Thin Ring Sector Plates. L. I. Deverall and C. J. Thorne. *American Society of Mechanical Engineers, Applied Mechanics Division, West Coast National Conference, Stanford, Calif., June 22, 23, 1951, Paper No. 51–APM-1.* 5 pp., illus. 10 references.

The finite Fourier transform is used to find the deflection of a thin homogeneous isotropic plate whose planform is a sector of a circular ring and which has arbitrary but given deflection and bending moments along its straight edges and any physically important edge conditions along its curved edges. Values of the constants are given for the three physically important combinations of edge conditions at the two curved edges.

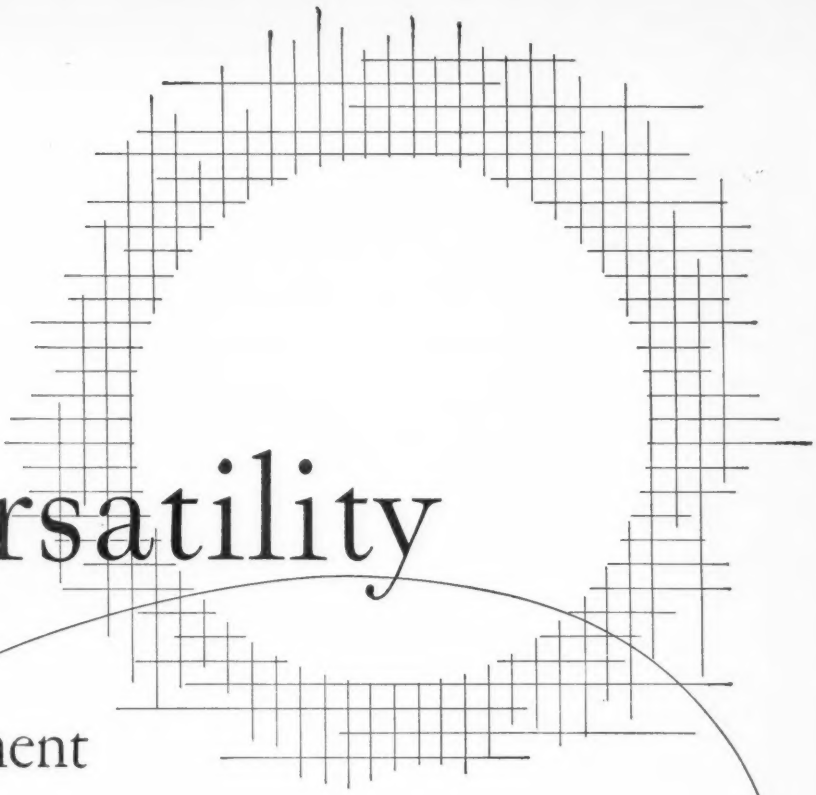
Calculating Deflection in Circular Plates. William A. Nash. *Machine Design*, Vol. 23, No. 7, July, 1951, pp. 145–148, illus. 2 references. Analysis of the problem of unsymmetric distribution of shearing forces or bending moments applied to the edge of a circular plate, applying thin plate theory.

The Boundary-Value Problems of Plane Stress. Rosa M. Morris. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 248–256. 3 references. Complete solutions for the stresses in an aeolotropic elliptic plate under three cases of edge loadings.

Beitrag zur Statik des Balkens von endlicher Breite (Statik plattenartiger Träger). I, II. H. Schürch. *Zeitschrift für angewandte Mathematik und Physik*, Vol. 2, Nos. 1, 2, January, March, 1951, pp. 26–34; 92–108; illus. 7 references. In German.

Contribution to the statics of a beam of finite width (plate-like structures), with application to the calculation of low-aspect-ratio wings on the basis of plate theory, taking into account variable local stiffness, anisotropic elastic behavior, and oblique and curved edges. **I.** Extension of plate theory to the sandwich plate; differential equation of the elastic surface; methods of solving the differential equation of deformation; statics of the simple beam; statics of the wide beam. **II.** Approximate solution with the aid of regular wing theory; transverse bending; extension of the deflection theory; calculated examples.

(*Continued on page 90*)



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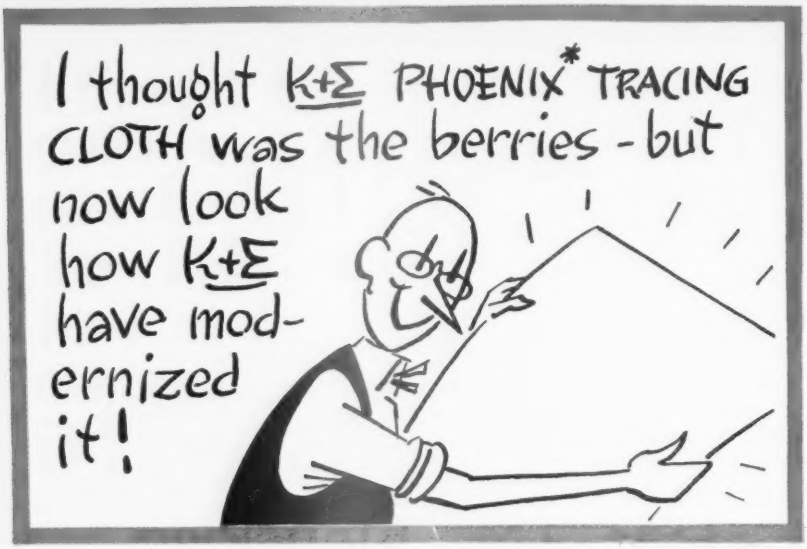

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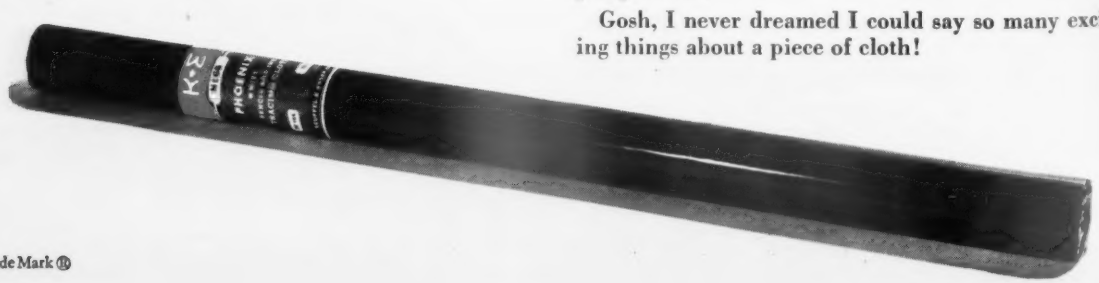

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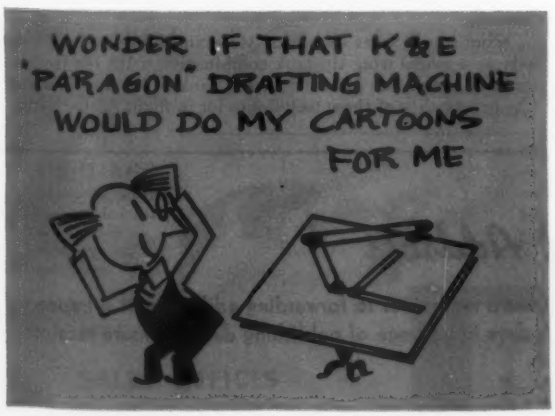

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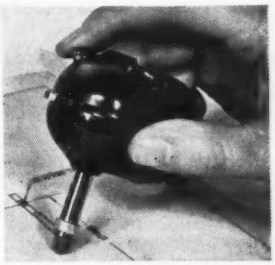

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Aeronautical Reviews

(*Continued from page 86*)

Thermodynamics (18)

Solution of a Heat Flow Problem. J. R. M. Radok. *Australian Journal of Scientific Research, Series A, Physical Sciences*, Vol. 4, No. 1, March, 1951, pp. 12–15, illus. 1 reference. Theoretical solution of the two-dimensional problem of heat flow in a rectangle that has the two opposite sides radiating outwards.

The Application of Relaxation Methods to the Solution of Non-Elliptic Partial Differential Equations. I—The Heat-Conduction Equation. D. N. de G. Allen and R. T. Severn. *Quarterly Journal of Mechanics and Applied Mathematics*, Vol. 4, Part 2, June, 1951, pp. 209–222, illus. 3 references.

Heat Conduction in Simple Metals. M. L. Storm. *Journal of Applied Physics*, Vol. 22, No. 7, July, 1951, pp. 940–951, illus. 26 references.

Mathematical analysis of the partial differential equation of heat conduction, considering the dependence of the thermal parameters upon the temperature. The thermal parameters of simple metals are studied to determine the validity of the analysis of the heat conduction equation.

Temperature Distribution in Internally Heated Walls of Heat Exchangers with Noncircular Flow Passages Using Coolants with Very Low Prandtl Number. E. R. G. Eckert and George M. Low. *U.S., N.A.C.A., Technical Note No. 2401*, July, 1951. 29 pp., illus. 5 references.

Development of a method for determining the temperature distribution within the coolant and passage walls of a heat exchanger composed of noncircular flow passages; the distribution is calculated for rectangular and triangular passages.

Heat Transfer Between Solids and Gases Under Nonlinear Boundary Conditions. W. Robert Mann and Frantisek Wolf. *Quarterly of Applied Mathematics*, Vol. 9, No. 2, July, 1951, pp. 163–184, illus. 6 references.

Investigation of a nonlinear boundary value problem at the interface between a gas and a semisolid, assuming that the film transfer factor is a function of the surface temperature.

Analytical Investigation of Fully Developed Laminar Flow in Tubes with Heat Transfer with Fluid Properties Variable Along the Radius. Robert G. Deissler. *U.S., N.A.C.A., Technical Note No. 2410*, July, 1951. 28 pp., illus. 7 references.

Equations for the velocity and temperature distributions in a laminar flow of gases or liquid metals through a tube are derived for the fully developed boundary layer. The Nusselt Number and friction parameter are obtained from the equations.

A Study of the Mechanism of Boiling Heat Transfer. W. M. Roshenow and J. A. Clark. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 609–616, Discussion, pp. 616–620, illus. 16 references.

Analysis of the heat quantity required to form a vapor bubble in a liquid using high-speed motion pictures of boiling heat transfer in forced convection. A procedure is developed for calculating the net heat transfer required to form a bubble of a given size.

Vaporization Rates and Heat-Transfer Coefficients for Pure Liquid Drops. Robert D. Ingebo. *U.S., N.A.C.A., Technical Note No. 2368*, July, 1951. 32 pp., illus. 6 references.

Experimental analysis, based on the heat-balance concept, of the effect of air temperatures on the rate of evaporation of a drop of pure liquid. Nine liquids, with latent-heat values of 50–500 gram-cal. per gram, were tested in an air temperature range of 30°–500°C.

A Summary of Viscosity and Heat-Conduction Data for He, A, H_2, O_2, N_2, CO, CO_2, H_2O, and Air. F. G. Keyes. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 589–596, illus. 25 references.

Collection of available data; development formulas for viscosity and heat-conduction in empirical equations that contain specific constants for the gases studied; tables of constants.

Measurements of the Heat Conductivity of Nitrogen-Carbon Dioxide Mixtures. F. G. Keyes. *American Society of Mechanical Engineers, Transactions*, Vol. 73, No. 5, July, 1951, pp. 597–601, Discussion, pp. 601–603, illus. 20 references. Measurements at 0°, 50°, and 150°C.

Water-Borne Aircraft (21)

Landing Characteristics in Waves of Three Dynamic Models of Flying Boats. James M. Benson, Robert F. Havens, and David R. Woodward. *U.S., N.A.C.A., Research Memorandum No. L6L13*, May 7, 1947. 42 pp., illus. 4 references.

Basic Research Helps Solve Seaplane Design Problems. John D. Pierson. *SAE Journal*, Vol. 59, No. 7, July, 1951, pp. 42–45, illus. (Based on a paper.)

Wind Tunnels & Research Facilities

New Way to Study Altitude Flow. *Aviation Week*, Vol. 55, No. 3, July 16, 1951, pp. 50, 53, illus.

University of California superaerodynamic wind tunnel for flow studies at simulated altitudes of 80–200 miles uses a molecular beam directed at models in an evacuated chamber.

Note on the Pressure Drop Characteristics of Baffles for Use in Wind-Tunnel Model Tests of Cooling Duct Systems. J. Seddon and A. Spence. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2425*, 1951 (April, 1944). 10 pp., illus. 4 references. British Information Services, New York. $0.50. Design of baffles for representing radiators; results of calibration of various types of baffles; design formula; use of baffles for representing air-cooled engines.

Power Unit for High-Intensity Light Source. Allen E. Young, Stuart McCullough, and Richard L. Smith. *U.S., N.A.C.A., Research Memorandum No. E50K27*, July 9, 1951. 11 pp., illus. 1 reference. Development of a high-intensity, short-duration light source for use in projector-type optical systems.

Investigation of Flight Flutter Testing Technique. Martin D. Schwartz and Donald L. Wrisley. *Aeronautical Engineering Review*, Vol. 10, No. 8, August, 1951, pp. 24–34, illus. 21 references.

Wind-tunnel tests on steady-state and pulse-excitation methods on a model wing-tip tank combination, with the mechanism causing unbalance installed in the tank. Tests results showed the practicality of these techniques for in-flight flutter testing.

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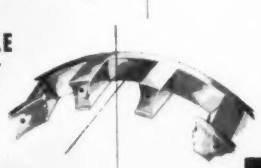

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Aeronautical Reviews — BOOKS

Basic Wing and Airfoil Theory

By Alan Pope. New York, McGraw-Hill Book Company, Inc., 1951. 295 pp., illus. $5.00.

Basic Wing and Airfoil Theory, by Alan Pope, is an outgrowth of the course that has been presented by the author for the past 10 years at the Georgia Institute of Technology. Basically, it is a compilation of the fundamental works of Prandtl, von Kármán, Theodorsen, Glauert, Trefft, and Weissinger. In addition, it includes the improvements and simplifications that have appeared in later years in a variety of technical papers.

As a general rule, such compilations are always welcome and find great acceptance by students, no matter how poorly organized and written. However, Pope, in his customary lucid style, veritably takes the reader by the hand and gently guides him through the intricacies associated with airfoil theory. This, and the unusual scope of the subject material, combine to form a valuable addition to the aerodynamicist's library.

The closest approach to the text may be found in Volumes I, II, and IV of Durand. There, prior knowledge to notation is a necessity, and the mathematical treatment makes stringent demands on the average investigator. On the other hand, each chapter of *Basic Wing and Airfoil Theory* is an entity and, as such, should prove extremely useful as a reference to the casual researcher. Primarily, however, the book is directed toward the college senior and first-year graduate student. For the benefit of the former, the first two chapters include the bases of vector analysis, complex variable, and Fourier series theory. The text is so organized that it may be used equally well for a full year or a half-year course.

The theory presented includes the various transformations, the methods of design and treatment of thick and thin airfoils, the determination of chordwise and spanwise pressure distribution, the complete analysis of the field of flow around wing-body combinations, and, throughout, the means of successfully designing arbitrary wings.

Several sections are outstanding either for their clear explanation or derivation, or for indelibly underlining certain facts and procedures that are not widely realized. In particular, Pope's explanations of the phenomena of "tuck-under" (page 226) and of the superposition possibilities of the flat-plate pressure distribution (page 110, etc.) are decidedly superior. Chapter 11, covering the field of flow about the wing, is done with much clarity and in great detail, as are the treatises or corrections for nonelliptic loading. Finally, any mysteries that may have surrounded the mechanics of the Joukowski transformation have at last been brought to light.

The reader is also impressed by the prodigious amount of work that must have gone into the preparation of the book. When Pope states that 36 columns are required to perform a pressure-distribution calculation, he promptly demonstrates the computation of each of the columns. Whenever he states a proved theoretical result, he shows the corresponding experimental evidence and explains the cause of discrepancy. In addition, the Professor introduces several innovations in formulation—i.e., he gives the formula for horsepower required to overcome induced drag and presents downwash velocity in terms of free-stream velocity instead of the usual elliptic-wing lifting-line downwash.

There is, however, a less bright side of the picture. The basic shortcoming is Pope's failure to indicate how the incompressible theory covered in his book can be extended to include the effects engendered by high-speed flight and modern plan forms. Thus, the researcher must still resort to the journals to gain information on the latter-day applications of the old theory. Hints of these are given and are then forgotten. In the same mode, the author will sometimes make statements whose logical conclusions are obvious to him, whereas two or three missing steps are required for the student's mental process.

There are other minor deficiencies. A great deal of time is spent on the techniques of the inverse problem, but a clear exposition of what is desirable in a pressure distribution is not forthcoming.

The reviewer realizes that it is extremely difficult to prepare suitable problems for such a text. They will either require hours of labor or be exceedingly deep. A middle ground probably exists. Nevertheless, Pope's problems often appear naive.

Though derivations are generally excellent, those on the Biot-Savart law are unnecessarily complicated, and the section on circulation is marked by the unfortunate (but correct) usage of the word "circulatory" as a synonym for irrotational. The latter could easily cause a state of chaos in the student's mind. The second edition should also correct the six or seven typographical errors that may be found.

In summary, Pope has performed a valuable service to teachers and students alike in packing so much valuable information under one cover. As a by-product, it is hoped that it will inspire someone to write an equally inclusive supersonic wing and airfoil theory as a logical outgrowth of the multitude of advances that have been made in this field.

Dr. Robert F. Brodsky
Supervisor—Aeronautical Division
Research Department
Sandia Corporation

For information on I.A.S. Library Service Facilities, see page 59

Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

An Introduction to the Theory of Control in Mechanical Engineering

By R. H. MacMillan. New York, Cambridge University Press, 1951. 195 pp., illus. $6.00.

Considering the small size of this book, the author has done a rather remarkable job of accomplishing his purpose—"Textbooks on servomechanisms and feedback amplifier theory have been published in America, but since no book devoted to the theory of control has yet appeared in this country, this one has been written to fill the gap." Mr. MacMillan's book is intended as an introduction to the subject but is more than that. The book, because of its broad approach and generalization of principles, goes a long way toward providing the engineer with the tools needed to analyze control systems and to evaluate his own designs. It does not suffer, however, from being too general in its

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presentation because the fundamentals are illustrated with specific examples. The book provides a definite incentive for more detailed study, if required, and provides the means in the form of an excellent bibliography of books, papers, and articles on the subject of automatic systems.

The first chapter deals in general terms with the basic concepts of control, differentiating between the open- and closed-loop control system. The reader is next introduced to the commonly used elements in modern control systems, such as hydraulic pumps, synchromotors, pneumatic relays, and mechanical torque amplifiers. The concept of transfer functions is introduced, and these are derived for the various components.

A discussion of simple servosystems follows. Equations for the transient and steady-stage solutions of these systems are derived and solved by classical methods. Routh's criterion for stability is presented.

The more highly developed methods for analyzing complex control systems are dealt with next. By the useful concept of transfer functions, the governing equations of more complicated control loops are readily obtained. Then the solution of these equations using complex numbers and Laplace transformations is presented.

The final chapter of the book is an introduction to graphic methods of analyzing control systems. Both the transient response and harmonic response (Nyquist) loci are found graphically for particular control systems. These are then interpreted to find the important parameters of the control loop—i.e., natural frequency, stability, best loop gain factor, etc. Lastly, attenuation and phase diagrams are introduced, and their use in predicting the best overall gain of a control loop is discussed.

Consistent with the condensed completeness employed throughout, the appendixes on complex numbers and the Laplace transform method are convenient for the casual reader.

Although the material covered in Mr. MacMillan's book has been presented before by other authors, his work is outstanding in its clear organization of what can be an extremely confusing subject. At all times, the reader can see how each phase of the analysis fits into the broad purpose of the book. Before being asked to follow an involved mathematical derivation, a clear picture of its part in the overall evaluation of a control system is presented.

If the author's work has any serious fault, it is that he often demands more facility with mathematics than the average engineer possesses. More detailed analyses would make for easier reading, but obviously this has been sacrificed in the interest of brevity and purpose. Stylewise it is interesting to note that this technical text is written in the first person. Mention must also be made of the sprightly chapter-heading quotations that are most appropriate.

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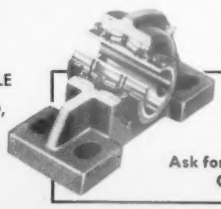

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gain a clear understanding of the mode of operation of such controls, (2) to enable the performance of a proposed control system to be evaluated, and (3) to gain some insight into the design of a control that will attain a specific performance—this book will be extremely useful. The author has enriched the technical literature of his country.

CHARLES F. SAVAGE
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The Principles of Air Navigation

By E. W. Anderson. London, Methuen and Company, Ltd., 1951. 364 pp., illus. 25*s*.

In addition to having British and American air-line experience, the author is also a wing commander in the Royal Air Force and took part in the flights of the *Aries* in the north polar regions. With this background, one has a right to expect a well-rounded text that reflects navigation as it is currently practiced. In this, the reader will not be disappointed.

In a foreword, the author states that the book was written "in an attempt to show how simple is this business of conducting an aircraft on its way across the sky." In this one respect, he has rather conspicuously failed. No matter how simply it is presented, by the time electronic systems of navigation and air-traffic control, pressure-pattern flight, and the many other recent developments have been considered, the conviction cannot be escaped that no longer is this business simple.

Apparently, in Britain, as in the United States, a number of texts have been constructed around the questions of the air navigation examinations. The author considers this unsound and objects that for the most part these questions are concerned with purely academic plotting problems. Instead of using this approach, he has attempted to provide the necessary background of theory for the practical airman. The stated aim of the book is to accomplish this "without delving into unnecessary mathematics." However, the first paragraph of the book reads as follows:

"The language in which a science may most easily be explained is mathematics. Without it we can do little more than scratch the surface earnestly, like hens. Let us therefore revise the comparatively simple mathematics that we shall need for the business of air navigation."

With this introduction, a few practical applications of elementary trigonometry are reviewed (reasonably sugar-coated), and the theory of probable errors is treated in some detail. Frequent use is made of the theory of probable errors throughout the text in an effort to evaluate the accuracy to be expected of the various methods of navigation and equipment.

The book is extremely interesting because its approach to the whole subject is so different from that of any other existing text. Its 14 chapters are divided into five major sections, as follows:

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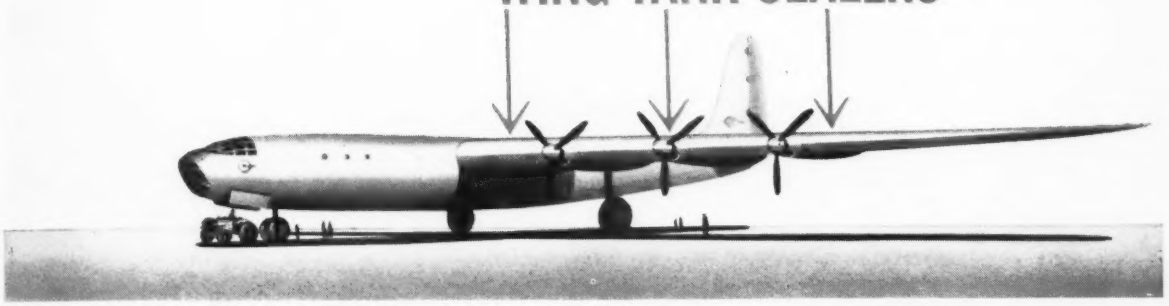

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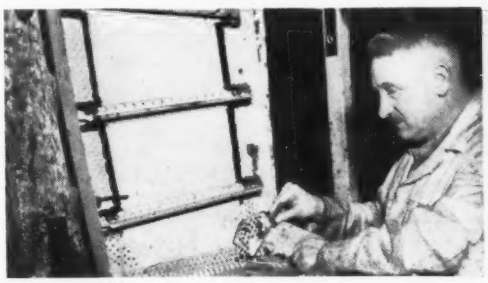

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Part II is chiefly limited to a consideration of charts and the various map projections, compasses, and navigation instruments.

Part III consists of two chapters. The first treats of the mechanics of winds, fronts, and pressure-pattern methods. The second deals with computers and the triangle of velocities, planning (choice of route, air speed, altitude, and time), and the preparation of flight plans.

Part IV discusses first the principles of position lines and fixes and then the various navigation aids. This is followed by a chapter on radio navigation, a chapter on radar, another on the several hyperbolic systems, and a chapter on celestial navigation.

A final section, Part V, summarizes the practice of dead reckoning and the special techniques of long-range navigation, short-range navigation, tactical navigation, and other related problems.

A distinctive feature of the book is its emphasis on mathematics instead of the usual approach through graphic methods. Oddly enough, its greatest weakness is in this field, for obvious mistakes in simple arithmetic are so general that they lessen confidence in the mathematical principles being demonstrated.

American students will probably be somewhat confused by the differences between American and British terminology—a difficulty common to most British texts in this field.

Fairly complete coverage is given to the many recent versions of radio and hyperbolic systems of navigation, although in one brief text, dealing with the whole broad field related to navigation, one could not expect much more than a "survey-of-the-field treatment."

In conclusion, the text is a worthwhile contribution of a practical navigator of broad experience and background. It deals not only with the methods and equipment currently in use but also with the principles behind them so that the airman may know what to expect of them.

THOBURN C. LYON
Consultant
Washington, D.C.

Rockets, Missiles, and Space Travel

By Willy Ley. New York, The Viking Press, 1951. 436 pp., illus. $5.00.

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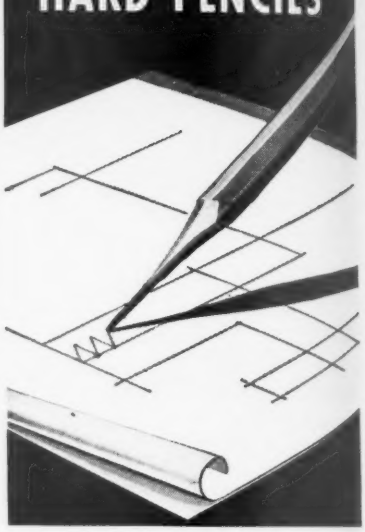

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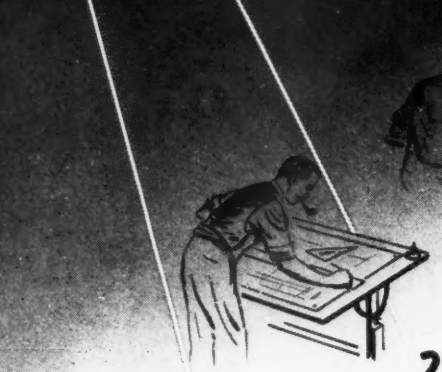

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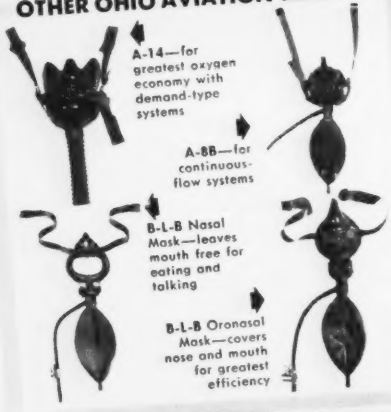
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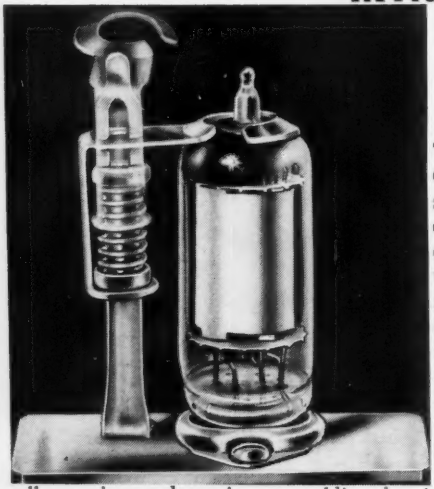

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To Willy Ley, a pioneer rocket experimenter and lecturer who chronicled the pre-World War II history of rocket development and space-travel theory, published under the title *Rockets* in May, 1944, progress might have appeared just a bit too fast, for his book was out hardly a fortnight when the German V-2's began to land in London. New material covering this and other war rockets necessitated enlarging the book, which appeared in 1947 as a revised edition called *Rockets and Space Travel*. Further developments since then, notably the 250-mile altitude record of the two-stage American WAC-Corporal rocket, the ending of the sonic barrier myth by the X-1 rocket-airplane flights, and additional released material on missiles provided further stimulus to the space-travel idea and led to the present latest revision and enlargement, *Rockets, Missiles, and Space Travel*.

This book is divided into 12 chapters, 2 appendixes, and a bibliography. The first six chapters cover approximately the same prewar background as the earlier editions. However, what might have been a dry sequence of historical dates and events, is expertly brought alive by the author as a continuing struggle for the great idea of space travel to evolve into more definite form as celestial mechanics and the later sciences forge ahead. Because the author was an active participant in the Verein für Raumschiffahrt (Society for Space Travel) during its pre-Hitler existence from 1927 to 1933, his account of the early experimentation and clash of personalities and designs makes highly interesting reading.

Chapter 7, The Return of the War Rocket, discloses that Nobel initiated, and the Krupp organization continued, work with large black-powder rockets near the turn of the century. The French are credited with being the first to use incendiary antiaircraft rockets against such an ideal target as the huge hydrogen filled Zeppelins of World War I. The development of modern solid propellants for rockets is briefly traced from Professor Goddard's first use of smokeless powder through the various cordites and ballistites later found suitable for military rockets.

Chapter 8 is devoted to the story of Peenemünde, and a description of the work at White Sands Proving Ground follows in Chapter 9. As an example of how quickly new developments can turn prediction into fact, just as this was being written the radio announced a new high of 135 miles set by the flight of the American Viking No. 7 on August 7, 1951, thus taking the world record for a single-stage rocket away from the prior 114-mile record of a rebuilt German V-2. Mr. Ley reported the prior maximum altitude of Viking No. 5 as 107 miles and the prediction by the scientists studying the telemetered records from Viking No. 6 that if the motor had not cut off 10 seconds too early, the altitude would have been 135 miles!

Chapter 10, The Rocket into Cosmic Space, opens dramatically with what seems to be a science-fiction story. But

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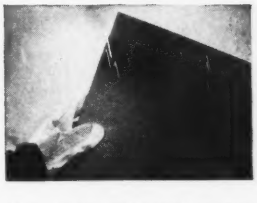

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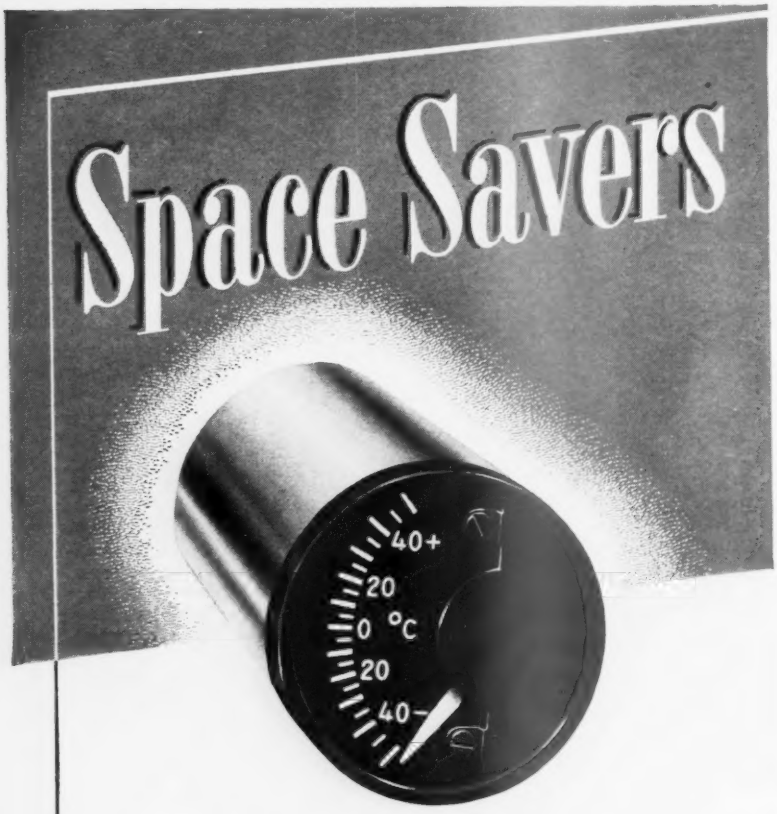

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it is not; it is a factual account of the 250-mile record shot made by the two-stage WAC-Corporal and V-2 rockets on February 24, 1949. Heartened by this demonstration of the correctness of the "step-rocket principle," by which even existing fuels theoretically can be used to step up to the 7-mile-per-sec. escape velocity for a shot at the moon, Mr. Ley goes on in Chapter 11, The Space Ship, to say, whereas "engineering predictions may be subject to revisions due to unforeseen developments," the adaptation of celestial mechanics to space-flight problems makes their solutions not "predictions" but "information about future events." Be that as it may, there are still colossal engineering problems to be solved before we can be in a position to hand up a space transit timetable. For example, some of the problems discussed are: the most economical path, or "orbit"; the high mass-ratios required; the return to earth by "braking ellipses"; "meteor bumpers" to ward off danger of such collisions; and cabin conditioning (oxygen, heat, food, etc.).

The mass-ratio problem, especially, is admittedly beyond present practical fulfillment for a full escape from the earth's gravitational field. Thus Mr. Ley concludes in Chapter 12 with a summary of the requirements and possibilities for a somewhat simpler Terminal in Space—i.e., attaining the approximate 5-mile-per-sec. velocity of a circular orbit outside the earth's atmosphere.

The remainder of the book includes nicely arranged tables of the available released data on recent rocket airplanes and missiles, with sources carefully noted, and an excellent bibliography.

Rockets, Missiles, and Space Travel is recommended to both the layman and technical reader for being up to date, readable, and informative.

ALFRED AFRICANO
Staff Engineer
Rocket Department, Propeller Division
Curtiss-Wright Corporation

Aircraft Jet Powerplants

By Franklin P. Durham. New York, Prentice-Hall, Inc., 1951. 326 pp., illus., diagrs. $6.65.

This latest publication in the Prentice-Hall Aeronautical Engineering Series should prove of great interest to colleges offering aeronautical engineering programs. But actually, its interest and usefulness go far beyond students in the classroom and reach out to tyro engineers in the jet-aircraft field who are still students and eager to apply their working knowledge of thermodynamics and fluid mechanics to an understanding of jet power-plant principles.

With the rapid advances of these last few years in aeronautical technology, especially in the fields of high-speed aerodynamics and aircraft power plants, aeronautical engineering colleges have been faced with the difficult problem of including in their curricula some introduction at least to compressible flow and jet power-plant theories in order to prepare their graduates to step into the

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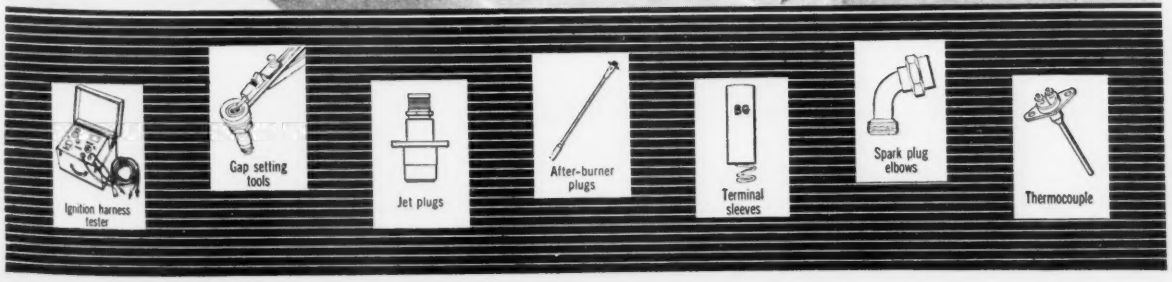

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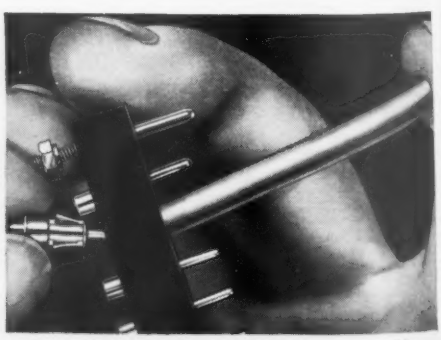

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present aircraft production and development field.

This new text, designed for junior and senior undergraduate levels, bridges the time gap by which efficient textbook material always lags behind development and research. One is pleased by the fact that it stresses fundamentals of thermodynamics and fluid mechanics. Good teaching is a process of development of the student's knowledge, understanding, and reasoning ability; the efficiency with which this process takes place depends upon the basic concepts used in the explanations.

Throughout, the author's explanation is clear and efficiently developed from elementary principles. It is true that advanced workers in this field may consider his assumptions in many cases to be grossly simplifying. However, the introductory theoretical approach to physical phenomena must always be accomplished by the reduction of variables, and the author's choice of assumptions leads to excellent generalized solutions of the engineering problems involved.

Frequent use is made of enthalpy-entropy diagrams in the explanations of efficiencies for the various components. And, although the development is thoroughly theoretical, the student is frequently recalled to actuality by numerous photographs and sketches of engines and their components.

For review purposes, the book may be divided into three sections. The first six chapters present the fundamental principles of jet propulsion and gas-turbine processes and performance. This section offers a discussion of the thrust and energy equations and the thermodynamic properties of air and gas followed by an application of these principles to the operation characteristics of both turbojets and turboprops.

The next five chapters treat in more detailed form the physical phenomena taking place in each of the five major components of a jet engine. These are: inlet diffuser, compressor, combustion chamber, turbine, and nozzle.

The third section consists of a rather complete basic discussion of the ramjet-engine principles and a somewhat sketchy overall view of rocket motors.

There are numerous worked examples in the text and problems at the end of each chapter. It would be too much to expect that one would remember all of the involved equations developed for the various processes, but the young engineer will have profited greatly by deriving the equations and applying them to the problems.

Later on, when the need arises, he will know what questions to ask himself in the presence of an actual engineering problem, and knowing the correct questions is, in most cases, the first step to the solution.

ROBERT A. KILLOREN
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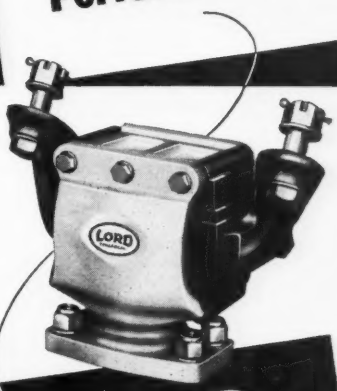

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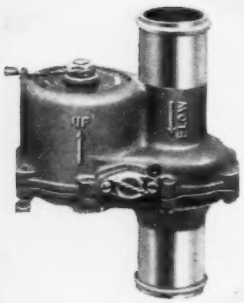

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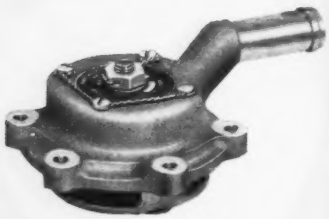
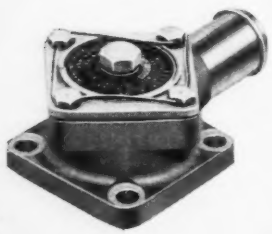


Oil tank vent valve



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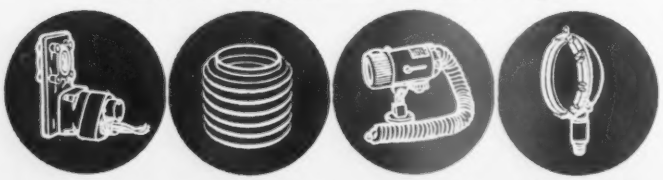

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Performance of the Piston Type Aero-Engine

By A. W. Morley. London, Sir Isaac Pitman & Sons, Ltd., 1951. 143 pp., illus. 25*s*.

This book is devoted primarily to an analysis of the effects of variations in atmospheric pressure and temperature and of supercharging on the power output of an aircraft engine. There is also a short section devoted to a consideration of the effect of these variables on fuel consumption. This work is supplemented by data from the Merlin II aircraft engine, which are analyzed according to methods previously set forth by the author. There is a chapter dealing with the thrust and drag of the exhaust and inlet system. The final two chapters deal with a similar although much less complete analysis of the two-stroke engine and of the compound engine. This latter engine, the author feels, has a secure place in long-range aircraft of the future.

The author states that the "monograph was originally written . . . for the Ministry of Aircraft Production." It was also apparently the result of a Ph.D. thesis at London University.

The most useful part of the book, in the reviewer's opinion, is the first part, which is devoted to the performance analysis. Consideration is given here to the effect of manifold pressure, inlet temperature, and exhaust pressure on air handling capacity. The effects of supercharging, fuel evaporation, and heat exchange in the intercooler and manifold are considered. It is to be regretted that checks between analysis and experiment are limited for the most part to the Merlin II engine. The reviewer believes that consideration of a wider range of variables would have shown that the problem is even more complex than the author's analysis would indicate. For example, there are data to show that at low ratios of back pressure to manifold pressure it is not possible to separate this effect from the effect of engine r.p.m.

It would have helped the reader if the author had chosen either to start his derivations with more fundamental thermodynamic concepts in order to show more clearly the nature of the assumptions involved, or to give a complete bibliography indicating where this material could be found. The bibliography contains five items.

This volume will be of interest primarily to people concerned with the prediction of the effect of altitude on the performance of reciprocating aircraft engines. The author's style is easy, and the mathematics included is elementary.

EDWARD S. TAYLOR
Professor of Aircraft Engineering
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Air Systems for Aircraft

By C. A. H. Pollitt. London, Sir Isaac Pitman & Sons, Ltd.; New York, Pitman Publishing Corporation, 1951. 176 pp., illus. $6.00.

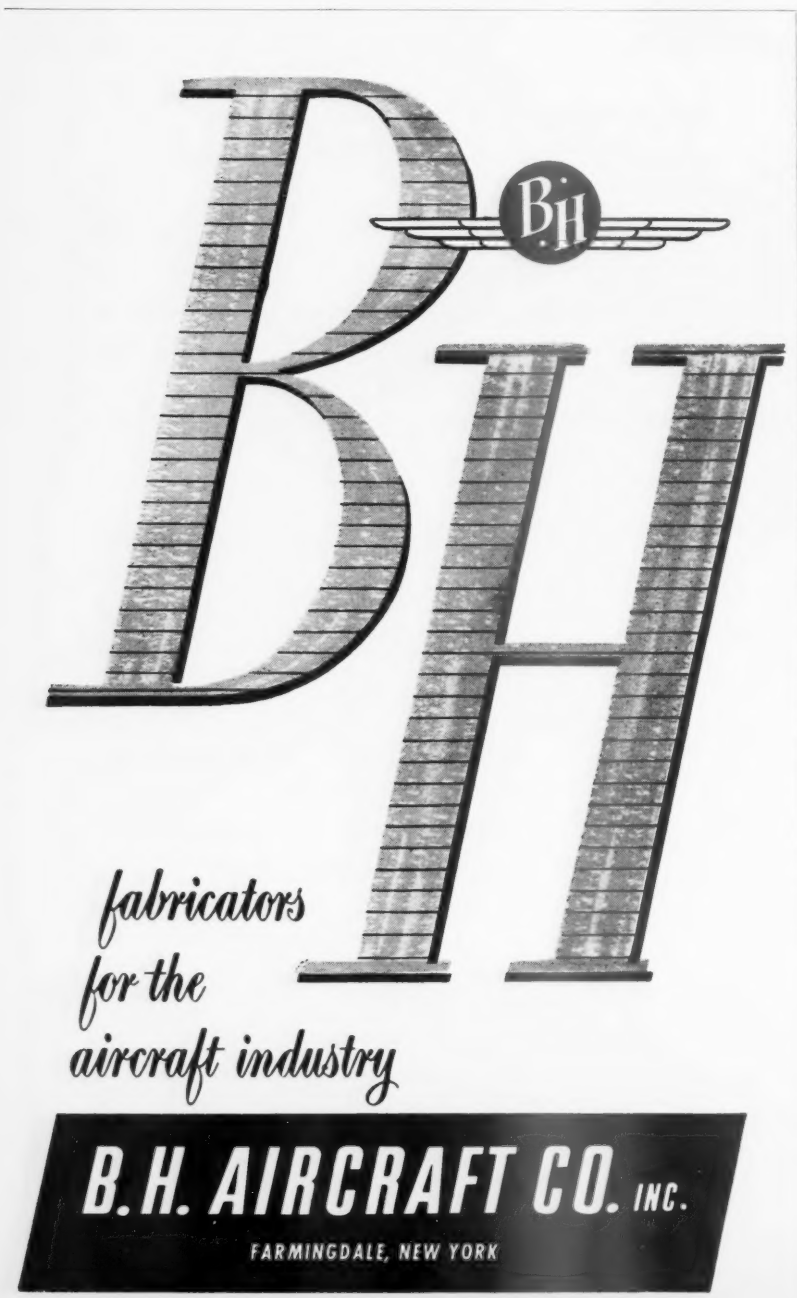
The remote, oft-times automatic, control of auxiliary equipment, the operation of retractable landing gears, the opening of doors, the deflection of flaps, the braking of the airplane, and a host of other mechanical services in the airplane can and are operated today by pneumatic systems.

This volume devoted to air systems in aircraft describes the operation of a number of systems along with the function and construction of individual parts.

Among the systems described, primarily of British origin, are the Hymatic compressed-air system, the Dunlop pneumatic brake system and gun-firing mechanisms, as well as a number of other Dunlop accessories. There are also descriptions of radiator-flap controls, electro-pneumatic supercharger controls, as well as reference to air-conditioning and cabin-heating systems, with descriptions of some American systems.

No space is devoted to theoretical concepts, formulas, or design criteria. For the engineer who is interested in what components comprise a given system and how these components may have been assembled by another manufacturer, the descriptions of the British systems covered by the author would undoubtedly be exceedingly useful.

FREDERICK K. TEICHMANN
Professor and Chairman
Department of
Aeronautical Engineering
New York University



Book Notes

ELECTRONICS

Theory and Design of Directional Antenna Systems. Carl E. Smith. Cleveland, Cleveland Institute of Radio Electronics, 1951. 117 pp., illus., diagrs. $3.00.

The theory and practical design of the shape and size of directional antenna systems are presented in coordinated form for professonal engineers interested in the basic principles of design and for broadcast engineers charged with the operation and maintenance of a directional antenna system. There is a final brief section on feeder-system design. Charts and data for antenna design are included in appendixes.

Electronic Motor and Welder Controls. George M. Chute. New York, McGraw-Hill Book Company, Inc., 1951. 348 pp., illus., diagrs. $6.50.

New developments since about 1943 are presented on resistance-welding control and electronic controls for motors. Part I, Resistance Welding Controls, consists of eleven chapters covering such new developments as sequence timers, synchronous combinations, and the frequency-changer type of welder control. The reader is assumed to have a knowledge of simpler electronic controls, although the discussions of these new complex circuits are amplified in footnotes and references are made to the author's more elementary books. Part II contains eleven chapters on electronic motor control, describing improved circuits, a variety of closed-cycle motor-control systems, and the stable operation of such systems. The author is an Application Engineer with the General Electric Company, Detroit. Equipment of other manufacturers is included in this book.

EQUIPMENT

ELECTRIC

Alternating-Current Electrical Systems for Aircraft. Prepared by Westinghouse Engineers. 2nd Ed. Lima, Ohio, Westinghouse Electric Corporation, Aircraft Department, January, 1951. Loose-leaf, illus., diagrs. $1.50.

The first edition was published under wartime restrictions in 1943, having grown out of the development of a.c. equipment for the B-35 and B-36 airplanes. The present edition retains the original purpose, to assist those who are laying out alternating-current systems for large aircraft, with the added objective of helping those who are now operating large aircraft equipped with such systems. Equipment that was on the drawing boards in 1943 is more fully described, as in the chapter on circuit breakers and relays. There is a new chapter on transformers and new material on a.c. fuses, power cables, and the constant-speed driving mechanism. There is a new chapter on variable-frequency systems for radio, radar, window-heating, surface deicing, lighting, galley loads, and other applications.

Transients in Power Systems. Harold A. Peterson. New York, John Wiley & Sons, Inc., 1951. 361 pp., illus., diagrs. $6.50.

This book is intended for engineers who are responsible for power system and apparatus design and for engineering students requiring a reference for advanced study in electric-circuit phenomena.

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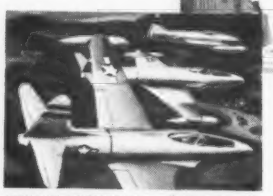

KOREAN BOOMERANG—Like Lockheed's famous Hudson Bomber ("Old Boomerang") of WW II, the F-80 *Shooting Star* has proved rugged in combat. Built to take terrific battle damage yet return to base, the F-80 did exactly that in Korea . . . another "Boomerang."

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Production of an undisclosed number of giant B-47 jet bombers has begun at Lockheed's Marietta, Georgia, factory.

As the world's leading producer of jet aircraft and modern high-speed transports, Lockheed is especially qualified to build the Boeing-designed B-47's for the Air Force. Production floor space at Marietta, plus Lockheed's California factories, makes Lockheed as large today as the entire U.S. air-frame industry in 1940.

What's going on at Lockheed?

Lockheed has developed a high-speed camera with a speed range of from 1,000 to 3,000 frames a second. At 3,000 per second, a 100-foot roll of 16-mm film goes through the camera in 1¼ seconds. Purpose of the speed: to check results when fast-dropping die hits a blank piece of metal. Objective: development of stronger, new-type alloys for greater, faster aircraft ... Another current research project creates arctic flying conditions 20,000 feet above the California desert. On an actual F-94 All Weather Jet Fighter, a spray bar shoots a fine, foggy mist on the nose and wing, building up layers of ice. Plane's de-icing equipment is thus tested in actual flight.

Past and future at Lockheed...

One of Lockheed's earlier transports, a Model 10 Electra, is approaching its 25,000th hour of flying time, in continuous service since 1937 for South Coast Airways, Pty., Ltd., of New South Wales (Australia) ... New Lockheed Super Constellations, in service by year's end, will be the largest, fastest, rangiest commercial transports in service. So well have earlier Constellations proved themselves around the world that more than 100 Super Constellations were ordered before the first production model flew ... The new Lockheed-developed thin wing for the advanced F-94C—so thin it looks almost fragile—is strong enough to support two fully-loaded Super Constellations (150 tons dead weight)—one at each wing tip. This new plane, America's continental defender because of its electronic superiority, contains enough installed electrical power to supply a small community.

The many new developments resulting from work with such tools as the differential analyzer and the transient analyzer, which are scattered through the literature or unpublished, are organized and consolidated. The bibliography contains about 500 items published between 1900 and 1951, and there is an index of authors. The rigorous mathematical circuit theory is not emphasized since the author aims to discuss what the analysis discloses, providing a basis for conclusions of value to the power system and apparatus designer. The author, who is Chairman of the Department of Electrical Engineering at the University of Wisconsin, wrote the book in cooperation with Central Station Engineering Divisions of the General Electric Company.

Transformer Engineering; A Treatise on the Theory, Operation, and Application of Transformers. L. F. Blume, A. Boyajian, G. Camilli, T. C. Lennox, S. Minneci, and V. M. Montsinger. 2nd Ed. New York, John Wiley & Sons, Inc., 1951. 500 pp., diagrs. $7.50.

The first edition was published in 1938. The book is addressed to engineers concerned with the specification, selection, application, and operation of transformers. Transformer design is discussed only as required to illuminate problems of transformer performance. In the present edition considerable new material has been added, particularly in the chapters on thermal characteristics of transformers, insulation, and load-ratio control practice. The authors are associated with the Transformer Department of the General Electric Company.

HISTORY

Fifty Years Fly Past; From Wright Brothers to Comet. Geoffrey Dorman. London, E.C.4, Forbes Robertson, Ltd., 1951. 346 pp., illus. 15*s*.

Because of his broad experience as an aviation journalist and through tours of duty in two world wars, the author was personally familiar with many of the events described in this history. Where he did not see the events, he checked his facts with someone who had had personal experience with them. For example, Griffith Brewer checked the data on the Wright Brothers, and he and other founder members checked the facts on the early history of the Royal Aero Club. The book supplies an authentic and useful rapid survey, from the British point of view, of the history of the first half century of flight. As it is intended to be a reference work as well as a readable history, official records are retrospectively and systematically reported, and indexes of personal names and of British air-line and manufacturing firms are provided. There is also a useful list of abbreviations.

MACHINE ELEMENTS

Engineering Design. J. E. Taylor and J. S. Wrigley. 3rd. Ed. London, Sir Isaac Pitman & Sons, Ltd., 1951. 137 pp., diagrs. 18*s*.

This textbook for engineering students is intended to integrate machine design with such relevant subjects as strength and properties of materials, metallurgy, and such branches of applied mechanics as the theory of machines. Following introductory material along these lines, the greater part of the book (pp. 23–133) is concerned with the application of principles to the design of 19 simple machines, such as hydraulic pipe joints, a line shaft, a spur gear and pinion, a centrifugal clutch, a venturi meter, a centrifugal pump, and a bevel-gear drive. The authors are Heads of the Engineering Departments, respectively, of the Technical College at Cardiff and Harris Institute at Preston.

MATERIALS

The Structure and Mechanical Properties of Metals. Bruce Chalmers. (Monographs on Metallic Materials, Published Under the Authority of The Royal Aeronautical Society, Vol. 2.) New York, John Wiley & Sons, Inc., 1951. 132 pp., illus., diagrs. $3.50.

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This book is written for the engineer whose primary concern has been with manufacturing processes, heat treatment, and the mechanical properties of metals. The way in which a pure metal is held together and the effects of alloying elements on the structure are discussed in the first two chapters, followed by considerations of the effect of distortion and heat treatment on structure. A brief and general account is given of methods for the determination of structure, and the book ends with a chapter on the more important mechanical properties and their dependence on the structure, including elastic properties, elastic limit, proof stress and yield point, ultimate tensile strength, hardness, toughness, creep, and fracture. The author is a Professor of Physical Metallurgy at the University of Toronto.

1951 SAE Handbook. New York, Society of Automotive Engineers, Inc., 1951. 864 pp. $5.00 to S.A.E. members; $10 to nonmembers.

This new annual edition benefits greatly from the larger page (now 8¼ by 11 in.), which is more suitable for the printing of the numerous tables and drawings. The material has been thoroughly rearranged and considerably augmented, with new and revised standards in all sections. Ferrous Metals, Nonferrous Metals, and Threads, Fasteners, and Common Parts take up about three-quarters of the book. There is a separate section on electric equipment, including aircraft and airway lamps. S.A.E. standards of specific aeronautical interest are briefly described. The final sections deal with standards and procedures applying to surface vehicles.

PHOTOGRAPHY

High-Speed Photography, Vol. 3. New York, Society of Motion Picture and Television Engineers, 1951. 159 pp. $2.00.

This third volume contains 11 papers reprinted from 1950 and 1951 issues of the Society's *Journal*, a bibliography of 600 titles, and a cumulative index to the three volumes.

Contents: A Survey of High-Speed Motion Picture Photography, Kenneth Shaftan. Electrical and Radiation Characteristics of Flashlamps, H. N. Olsen and W. S. Huxford. Infrared Photography with Electric-Flash, Frederick E. Barstow. The Stroboscope As a Light Source for Motion Pictures, Robert S. Carlson and Harold E. Edgerton. High-Speed Photography of Reflection-Lighted Objects in Transonic Wind Tunnel Testing, E. R. Hinz, C. A. Main, and Elinor P. Muhl. The Pressurized Ballistics Range at the Naval Ordnance Laboratory, L. P. Gieseler. A 100,000,000 Frame per Second Camera, M. Sultanoff. Photography in the Rocket-Test Program, Carlos H. Elmer. The High-Speed Photography of Underwater Explosions, Paul M. Fye. A Simplified Body-Cavity Camera, A. P. Neyhart. The Cine Flash—A New Lighting Equipment for High-Speed Cinephotography and Studio Effects, H. K. Bourne and E. J. G. Beeson. Bibliography on High-Speed Photography Including Schlieren and Cathode-Ray Oscillograph Photography, Elsie Garvin.

POWER PLANTS

Gasturbinen mit Gleichdruckverbrennung (Gas Turbines with Constant-Pressure Combustion). Rudolf Friedrich. Karlsruhe, Verlag und Druck G. Braun, 1949. 139 pp., illus., diagrs. DM 10.80. In German.

The thermodynamic process in gas turbines is discussed in the opening section, followed by sections on compressors, combustion chambers, turbines, and heat exchangers. Construction materials and fuels are taken up briefly. There is a section on the use of gas turbines in stationary plants, aircraft, ships, locomotives, and other vehicles, and the book ends with considerations of further development and further applications. The book is intended for engineers who require a brief survey of the state of knowledge on the gas turbine. Tables of data on materials, compressors, and turbines for nonaircraft purposes are included, and there is a bibliography of about 80 references.

The Internal Combustion Engine. Edited by A. H. Franks. 2nd Ed. London, Sir Isaac Pitman & Sons, Ltd., 1951. 160 pp., illus., diagrs. 10*s*. 6*d*.

In this new edition of a book first published in 1943, the original purpose is continued—to acquaint drivers, mechanics, and others with the basic principles of the automobile engine and its maintenance. The treatment is clear and well illustrated. A new chapter on the diesel engine is included.

PRODUCTION

Aeronautical Drafting Manual. 3rd Ed. New York, Society of Automotive Engineers, Inc., July 1, 1951. Loose-leaf, $5.00 with binder; $3.00 without binder. New revision sheets only, $1.25.

This manual was originally issued in 1941 as a manual of *Aircraft Engine Drafting Room Practice*. It was revised in 1946 under its present title, having been expanded to include practices applying to the aircraft propeller and accessory industries, and air-line operations. The present revision consists of 45 pages providing new material on drawing mediums and reproductions, pictorial-type drawings, drawing numbering systems, drawing involute gear-tooth form profiles, extension springs, tables of material stock data, an entire new section on welding, and revisions of various other sections.

REFERENCE WORKS

Educators Guide to Free Films. Compiled and Edited by Mary Foley Horkheimer and John W. Diffor. 11th Ed. Randolph, Wis., Educators Progress Service, 1951. 462 pp. $6.00.

This new annual edition lists 2,121 titles of films, of which 444 were not previously listed. Over 200 of the films are listed under the subject of aeronautics, and there are about 100 films on machine-shop practice, 90 on physics, 150 on general science, and 75 on transportation. Films of aeronautical interest are included in these and other categories. The volume is well arranged, annotated, and indexed.

SCIENCES, GENERAL

MATHEMATICS

Linear Computations. Paul S. Dwyer. New York, John Wiley & Sons, Inc., 1951. 344 pp. $6.50.

In this book the general problem of numerical solutions for sets of simultaneous linear equations is attacked. The approach is a general mathematical one not designed specifically for statistical problems. The author describes the theorems and methods in terms of elementary algebra, proceeding into introductory material on determinants and on matrices, so that more powerful expositions are possible in the later chapters. As direct application of the methods to numerical problems is essential for their understanding, numerous illustrative problems are provided. Bibliographies are given at the ends of chapters, and there are indexes of authors and subjects. The author is Professor of Mathematics and Consultant to the Statistical Research Laboratory at the University of Michigan.

The Preparation of Programs for an Electronic Digital Computer. Maurice V. Wilkes, David J. Wheeler, and Stanley Gill. Cambridge, Mass., Addison-Wesley Press, Inc., 1951. 167 pp., illus. $5.00.

As of early 1951, the results of work at the Mathematical Laboratory of the University of Cambridge are incorporated into a detailed description of a system of subroutines for carrying out standard processes in an electronic digital computer. The aim of the work is to provide an adequate organization for the efficient use of the machine once it is designed. The methods are discussed in terms of the Electronic Delay Storage

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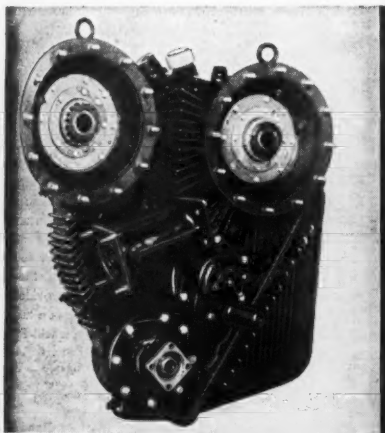

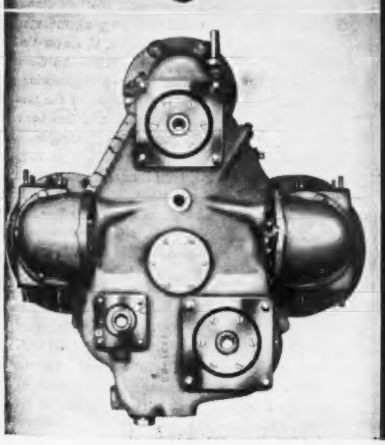

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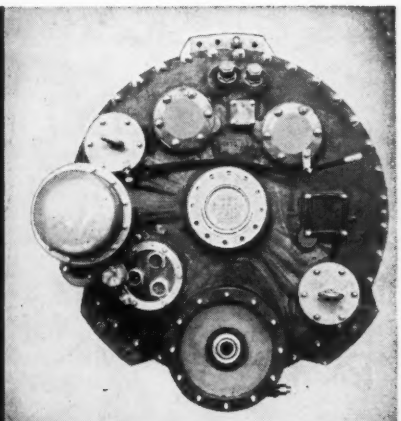

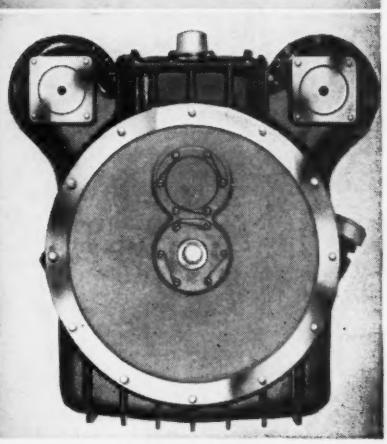

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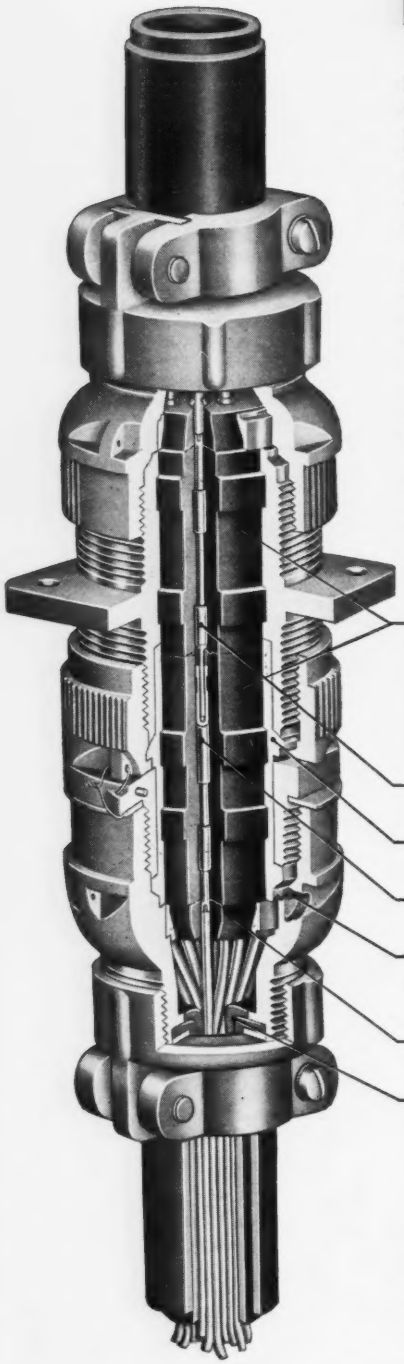

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Automatic Calculator (EDSAC), in use at Cambridge University since 1949, but for the most part they can be translated readily into other order codes. The book should be useful to present users of electronic digital computers and to potential users who are not specialists. Part I deals with the design of programs, input of orders, subroutines and parameters and their use in constructing programs, proofreading, location of mistakes, and counting operations. There is a separate chapter on the use of the EDSAC and its associated equipment, and a chapter of examples. Part II consists of detailed specifications of subroutines, and Part III gives programs of selected subroutines. A keyboard perforator code, the initial orders, control combinations, interpretive subroutines, and methods of counting in a simple cycle are detailed in appendixes.

Jacobian Elliptic Functions. Eric Harold Neville. 2nd Ed. Oxford and New York, Oxford University Press, 1951. 345 pp. $7.00.

In this new edition of a book first published in 1944, a new chapter has been added on Integrals of the Third Kind, the functions needed to complete the integration of a rational function of Jacobian functions, and corrections have been made in the plates. The original purpose has been retained—to examine Jacobian functions as constructed on a lattice and to restore them to the elementary mathematical curriculum. The first four chapters discuss the twelve primitive functions, and the following four chapters take up a standard elliptic integral and its inversion. Chapter IX deals with Functions and Integrals with Real Critical Values. In the last half of the book, the classical functions are discussed, considered as functions constructed on a canonical lattice. The author is a Professor of Mathematics at the University of Reading.

Mathematics for Technical Students, Book II. J. D. N. Gasson. Cambridge and New York, Cambridge University Press, 1951. 431 pp. $2.75.

The author's aim is to provide a complete course of study in mathematics for the second year of the British National Certificate in mechanical, structural, and electrical engineering. Algebra and trigonometry are covered in the first part, and the final half of the book is devoted to geometry, graphs, mensuration, and a short introduction to the calculus. Exercises are provided at all stages of the course. The author is a Senior Lecturer in Mathematics at the Chesterfield Technical College.

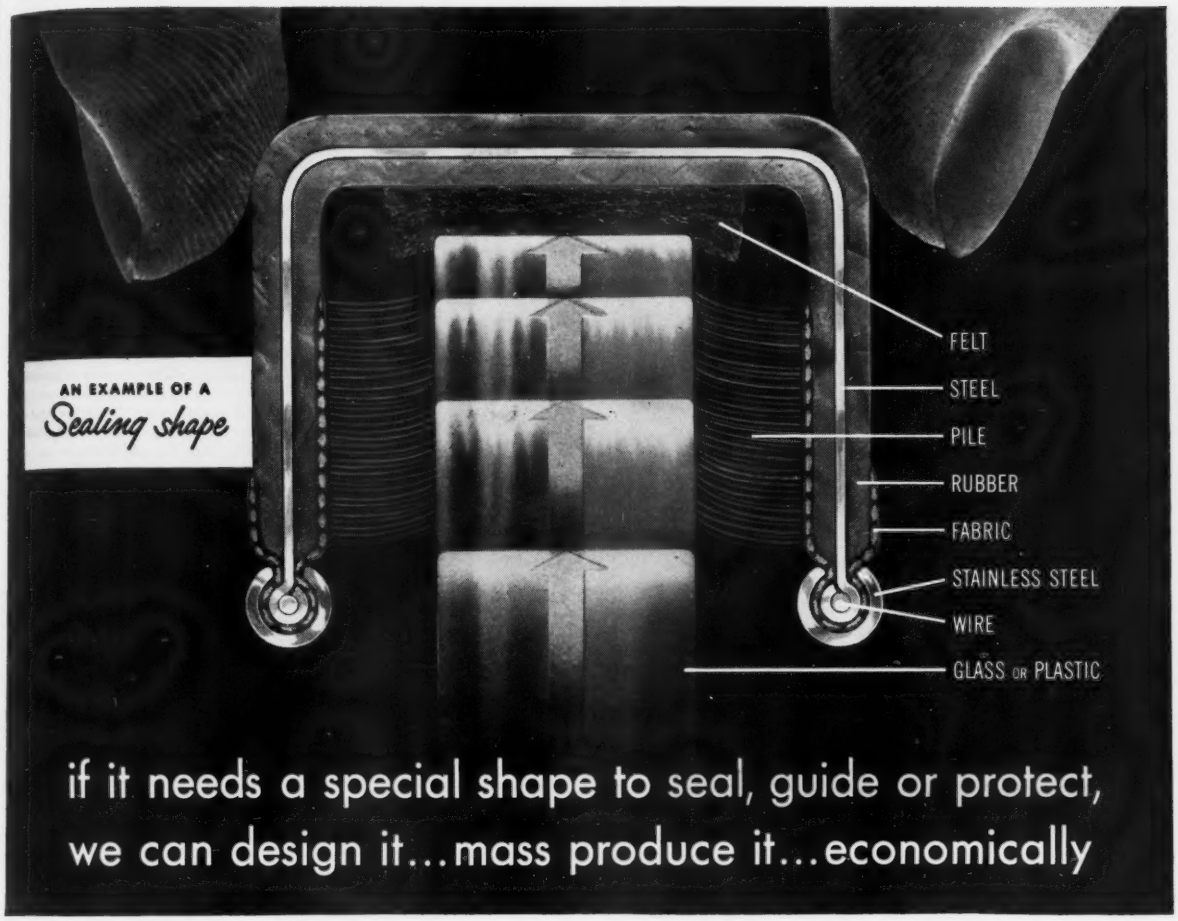
MECHANICS

Technische Schwingungslehre; Band I, Einfache Schwinger und Schwingungsmessgeräte. Karl Klotter. 2nd Ed. Berlin, Springer-Verlag, 1951. 399 pp., diagrs. DM 46.50. In German.

This textbook on vibrations in engineering was originally published in 1938. Part of the present volume was published in 1943 and has been revised and included in the section dealing with the measurement of mechanical vibrations and the dynamics of vibration-measuring apparatus. The first section of the book deals with the kinematics of simple vibrations considered generally. The kinetics of simple free and forced vibrations with linear and nonlinear characteristics are taken up in the main body of the book, which includes a detailed section (pp. 250–336) on vibration measurement. A separate section deals with vibrations of elastic bodies, with particular attention to mathematical methods. Two brief final sections cover resonance and self-excited vibrations. There are indexes of names and subjects. Professor Klotter teaches at the Technische Hochschule in Karlsruhe.

Applied Mechanics for Engineers. Charles Inglis. Cambridge and New York, Cambridge University Press, 1951. 404 pp., diagrs. $7.50.

This textbook is designed for a two-year course for the second- and third-year engineering student. The early chapters are concerned mostly with the statics of rigid bodies, but in Chapter VI, Deformation of Frameworks, the applications of displacement diagrams are emancipated from the rigid-body statics. Aside from other fundamental



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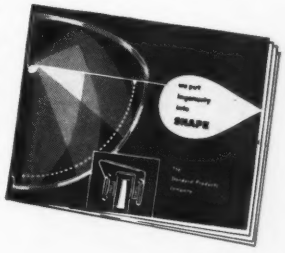

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PHYSICS

Ultrasonics. P. Vigoureux. New York, John Wiley & Sons, Inc., 1951. 163 pp., illus., diagrs. $4.00.

The author's purpose is to provide an introduction to the technique and the simpler aspects of the theory of propagation of ultrasonic vibrations in fluids. Apparatus and methods are discussed in chapters on Generation and Observation, and theory and results are taken up in chapters on Propagation, Gases, and Liquids. Principles are stressed in the discussions of techniques rather than details of apparatus and experimental procedure. There is a bibliography of about 345 items published since January, 1939, and indexes of names and subjects are included. Dr. Vigoureux is associated with the British Royal Naval Scientific Service.

Practical Electricity and Magnetism. Maurice Rubin. New York, Chemical Publishing Company, Inc., 1951. 356 pp., diagrs. $7.50.

The author's aim is to present an elementary survey of electricity and magnetism, with special emphasis on recent developments in magnetism, including shielding of radar systems, magnetic focusing of cathode-ray tubes, the use of permanent magnets instead of electromagnets, control of permanent magnets, and the development of new magnetic alloys. The first half of the book deals with theory, covering Electrostatics, Electric Charges in Motion, Electrical Meters and Measurements, Magnetism, Photoelectric and Thermionic Emission, and Electrical Conductivity of Gases. The final half of the book covers practical applications, including generators and motors, transmission lines, lighting, communications, radio, television, radar, protective measures, and other applications. There is a final chapter on recent developments. The author is Resident-Visiting Engineer on Radar at the Bell Telephone Laboratories.

The Earth's Magnetism. Sydney Chapman. 2nd Ed. London, Methuen & Co., Ltd.; New York, John Wiley & Sons, Inc., 1951. 127 pp., illus., diagrs. $1.50.

The first edition of this book appeared in 1936. It is designed as a broad account of our present knowledge of the earth's magnetic field and its changes. The mathematical aspects are kept to a minimum, and such related topics as earth currents, solar phenomena, or radio research are discussed briefly. There is a brief bibliography, and there are indexes of names, places, and subjects.

STRUCTURES

Relaxation of Constraints and Moment Distribution. (Mechanical World Monographs, No. 62.) Manchester, England, Emmott & Company, Ltd., 1951. 40 pp., diagrs. 3*s*.

The first half of this pamphlet is devoted to Southwell's relaxation method for the solution of structural problems. The physical picture is illustrated by a jack-and-clamp analogy. The second half takes up the moment distribution method of Hardy Cross, considered as a special case of the more general relaxation methods. Each method may be studied independently of the other.

THERMODYNAMICS

Einführung in die technische Thermodynamik, und in die Grundlagen der chemischen Thermodynamik. Ernst Schmidt. 4th Ed. Berlin,

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Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.

Springer-Verlag, 1950. 520 pp., diagrs. DM 30. In German.

This textbook was last revised in 1944. The present edition has been revised and is larger by over 160 pages. The discussions of the first and second laws compose the first six chapters, which are followed by a group of ten chapters on applications of the laws of gases and thermodynamics to various types of engines. A general discussion of gas engines, the equations of state of steam, solid bodies, applications to steam engines, combustion phenomena, and flowing motion of gases and steam are included here; there are separate chapters on jet engines, rockets, and ram- and pulse-jets. There are chapters on heat transfer, heat transfer through flow, and steam-gas mixtures. Applications of the first and second laws to chemical processes and a chapter on the third law (formally called the Nernst heat theorem) conclude the book. Steam and gas tables are included in appendixes, and there are indexes of names and subjects. The author is a Professor and Director of the Institut für Wärmetechnik, Technische Hochschule, Brunswick.

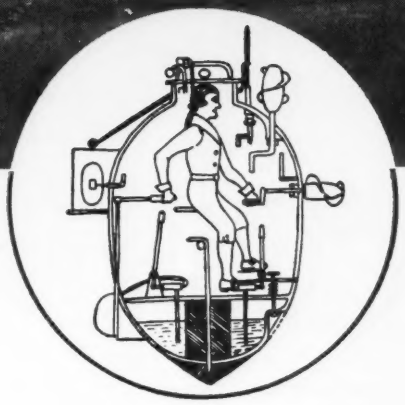
Introduction to Heat Transfer. Aubrey I. Brown and Salvatore M. Marco. 2nd Ed. New York, McGraw-Hill Book Company, Inc., 1951. 265 pp., diagrs. $4.50.

In this new edition of an undergraduate engineering textbook first published in 1942, the original purpose and arrangement have not been changed. Material on fluid flow has been considerably expanded, and revisions have been made in the discussion of estimating heat conduction by the mapping method. New material has been added to the chapters on conduction and radiation, particularly on the characteristics of insulating materials and the calculation of solar radiation. Data on the physical properties of liquids and gases have been revised. The number of problems has been doubled. The authors are Professors of Mechanical Engineering at The Ohio State University, where the senior author is Chairman of that department.

Attention Members!

All Members of the institute are invited to submit material concerning their activities for publication in the "News of Members" columns of the *Aeronautical Engineering Review*. Responsibility for new developments, awards or honors received, and appointments to new or additional positions are some of the items that your editors believe are of interest to other I.A.S. members. A brief letter or postal card giving exact details will be sufficient. Photographs accompanying news items will be welcomed and will be used where practicable.

Items submitted will be considered on the basis of their timeliness and general interest. Correspondence should be addressed to the News Editor, *Aeronautical Engineering Review*, 2 East 64th St., New York 21, N.Y.



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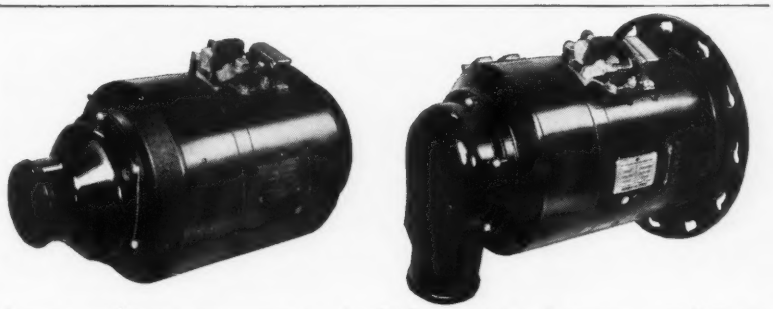
Our partners in expansion at present include more than 60 companies. While the list includes such well-known names as Apex, Universal Wire, Evinrude and Whirlpool, 90% of the subcontrators in this group are classified as small businesses.



Above are typical generators in the G29 series. The G29-7A, at left, features an axial air-blast inlet and 6-inch diameter mount, while the G29-8B, at right, features a radial air-blast inlet adjustable to any of 12 equally spaced positions. Integral mounting flange is 11-inch diameter.

Chief Engineer's Corner

Many of the basic design improvements in today's d-c aircraft generators are the result of J & H being called in to solve particular problems experienced in aircraft operation.

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J & H Generators are fully compensated with vacuum impregnated, baked and mechanically secured windings. They have high-altitude brushes and sparkless commutation. Dynamically balanced armatures are mounted on sealed pre-lubricated ball bearings and speed-tested. Blast cooling permits minimum size and weight for given ratings.

Since both the mechanical and electrical demands on generators vary widely, Jack & Heintz engineers are eager to work with manufacturers to select or design the right generator for the job. We also are in a position to furnish inverters and other accessories and controls best suited to the over-all system. In asking for specific data, please give as complete information as possible on service requirements . . . write JACK & HEINTZ, INC., Cleveland 1, Ohio.

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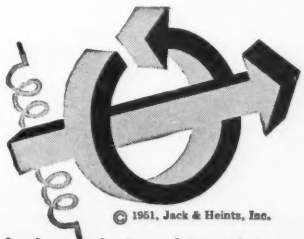

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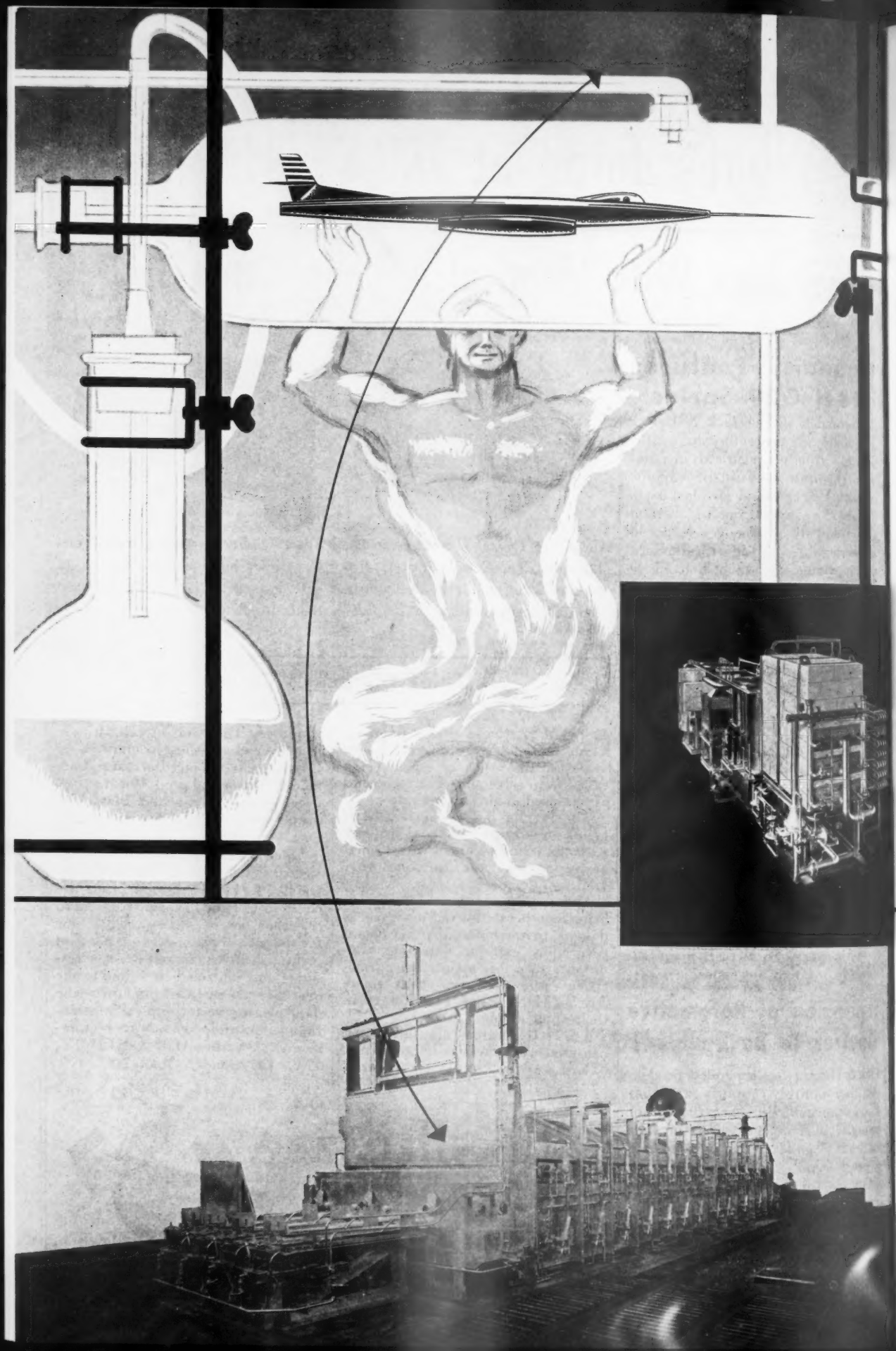
means electrical, hydraulic or mechanical devices designed to solve unusual problems of developing power, controlling it, or using it.



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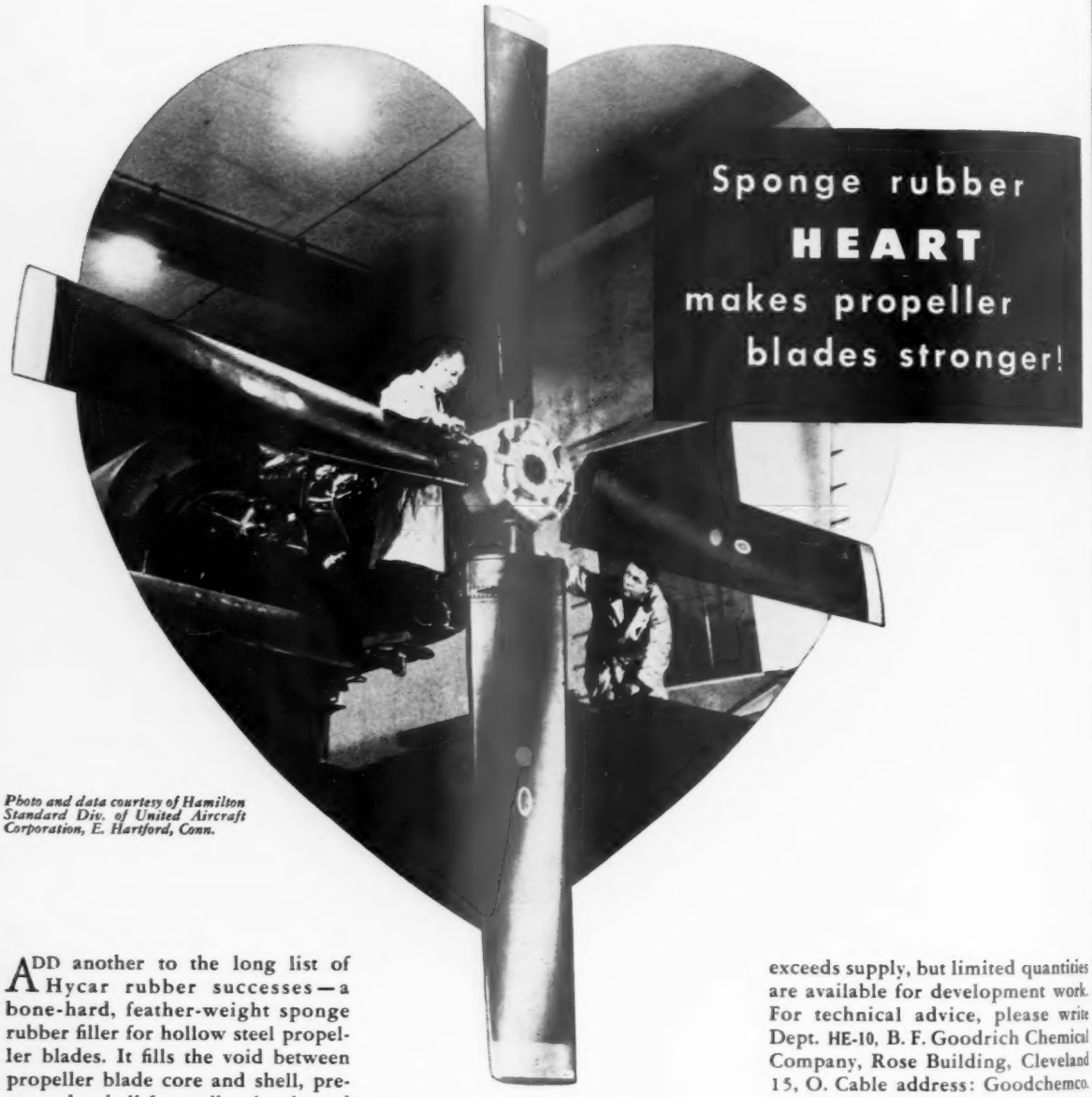

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ADD another to the long list of Hycar rubber successes—a bone-hard, feather-weight sponge rubber filler for hollow steel propeller blades. It fills the void between propeller blade core and shell, prevents the shell from vibrating in and out. It also supports the shell against the impact of rocks, ice and other material thrown up by the plane's undercarriage.

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Personnel Opportunities

This section is for the use of individual members of the Institute seeking new connections and organizations offering employment to Aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

Wanted

Aeronautical Engineer—To teach stress analysis, airplane design, and allied courses. Advanced degrees not necessary but several years of industrial experience required. Salary and rank dependent on qualifications. Address: Aeronautical Department, California State Polytechnic College, San Luis Obispo, Calif.

Aircraft Instrument Projects Engineers—For development of engine and flight-type electronically operated aircraft instruments. Position is with a small rapidly growing company that has an excellent reputation and record of achievement in these fields. Applicants must be fully experienced. Please send complete résumé to AVIEN, 34-56 58th Street, Woodside, N.Y.

Design Engineers—Mechanical, Structural, Electrical, Analytical—Degree not essential but desirable. For permanent work in the field of aircraft accessories, power-plant equipment, turbines, compressors, pumps, controls, aircraft carrier catapults, deck handling equipment, heat exchangers, special machinery. An expanding company in the growing Trenton industrial area (no traveling) provides unexcelled opportunities for professional advancement. Excellent salaries commensurate with education and experience. Interviews held regularly in Trenton and New York City. Write: Personnel Supervisor, Power Generators, Ltd., 25 North Montgomery Street, Trenton, N.J.

Aeronautical Engineer (Structures)—Vacancy for Aeronautical Engineer (Structures) GS-11, exists in the Civil Aeronautics Administration's Technical Development and Evaluation Center, located at Indianapolis, Ind. The position pays $5,400 per annum. The position is concerned with the execution of assigned projects, studies, investigations, developments, experimentation and testing of aircraft structures, structural components, structural material, and apparatus for evaluating aircraft structural characteristics. Must have a bachelor's degree or its equivalent in years of progressive engineering experience, plus 2½ years of aeronautical engineering experience. Applicants should submit Standard Form 57, Application for Federal Employment (available at any Post Office) to: Civil Aeronautics Administration, Technical Development and Evaluation Center, P.O. Box 5767, Indianapolis 21, Ind., Attention: Personnel Officer.

Physicist, Electrical or Mechanical Engineer—Graduate engineer for design, development, and testing of flight-test instrumentation. Must be capable of electronic design work associated with servosystems, strain gage measuring circuits, and other type instruments used in flight testing. Mechanical knowledge must be sufficient to lay out installation of test equipment in airplanes and design mechanical test equipment for instrument calibration work in laboratory. One or more years of experience with background of aeronautical engineering work desirable but not essential. Address replies to Dept. AER 8, Cornell Aeronautical Laboratory, Inc. 4455 Genesee Street, Buffalo 21, N.Y.

Instrument Engineers—Two or 3 years' experience in pressure sensitive instruments and small precision mechanisms, experimental and preliminary design work, regular products. Excellent working conditions. Résumé requested. Location, New Jersey suburban area. Wallace & Tiernan Products, Inc., 1 Main Street, Belleville, N.J.

Electronics Instrumentation Engineer—B.E.E. or B. Physics degree required with additional graduate work preferred. Minimum of 5 years of experience. This is a permanent position in charge of an electronics laboratory associated with an aeronautical laboratory. There also are some openings for electrical engineers with less experience. Salary is commensurate with experience. Graduate privileges are available. Liberal employee benefits. Housing not a pressing problem. Send letters of application to: University of Minnesota, Department of Aeronautical Engineering, Rosemount Research Laboratories, Rosemount, Minn.

Research Engineers, Aeronautical and Mechanical Engineers, Specialists in Applied Mechanics—Permanent opportunities in research and development including mechanical design, aeroelastic research, static and dynamic measurements, applied mathematics, engineering structures, and dynamic analysis. Industrial as well as military programs. Salaries in accordance with ability and experience. Located deep in the heart of Texas on the 4,000-acre Essar Ranch. Address replies to: C. D. Pengelley, Chairman, Engineering Mechanics Department, Southwest Research Institute, P.O. Box 2296, San Antonio, Tex.

Flutter Engineer—Permanent position for experimental and theoretical research in flutter, vibration, aeroelasticity, and dynamic loading. Two to 5 years' experience required. Salary commensurate with ability. Unique opportunity to join rapidly developing research organization located on the beautiful Essar Ranch. Address replies to: C. D. Pengelley, Chairman, Engineering Mechanics Department, Southwest Research Institute, P.O. Box 2296, San Antonio, Tex.

332. Engineers—Challenging situation for top-flight aeronautical engineers in fields of aerodynamics and aircraft design. Opportunity for creative work accompanied by excellent emolument.

331. Engineer—Design and fabrication in the field of aerophysics research equipment. Projects range from small subsonic wind tunnels to supersonic wind-tunnel models; high-speed gear boxes; missile air frames; rocket and ram jet power plants; and instrumentation. This is a career position in a growing organization.

327. Design Engineer A and Design Engineer B—Responsible positions requiring 3 to 5 years' experience in mechanical design of aircraft quality, preferably in gas turbines or similar type machines. Must be capable of working from design specifications in making layouts of complete parts or components including sheet metal construction, taking into consideration manufacturing costs, weight, stress, heat, material properties, mechanics, dynamics, and production problems. (Housing available.)

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

Available

345. Teaching—Ph.D. in Aero. Eng. Twelve years' experience in theoretical research and teaching. Desires to teach fluid and solid mechanics, aerodynamics, and applied mathematics at graduate level, with some sponsored research. Rank of Associate Professorship will be agreeable.

344. Aeronautical Engineer—With over 10 years' experience supervising design, development, and testing of high-speed aircraft. Desires position as Chief Preliminary Design Engineer, responsible for organizing development and proposal work. Excellent references. Eastern location preferred.

343. Pilot Engineer—M.S. in Aeronautical Engineering, 1951. Nine months Liaison Engineer; 1 year Flight-Test Analysis Lead Engineer. Commercial Pilot, 9 years, Instrument, Instructor, single- and multiengine land. 2,350 hours—1,051 single-engine, 1,300 multiengine. Seventy hours of stability and performance testing. Interested in obtaining a position involving test flying.

342. Administrative Engineer—Assistant to Executive—Fifteen years of varied experience in aviation and electronics. Presently with Navy research organization planning and conducting far-reaching investigations into advanced aircraft instrumentation. Previous experience in industrial and aviation electronics (Head, Control Laboratory, Lear, Inc.); Aircraft Ignition (Assistant Chief Engineer, Aero Spark Plug); Gas-Turbine Controls (Chief, Control Section, Fredric Flader, Inc.). Lecturer to instrument, aviation, and aeromedical groups on specialized man-machine aviation problems. Seeks supervisory or administrative position. Salary $9,000.

338. Engineer—Aeronautical graduate, 1941. Heavy production expediting and production design experience. Stress, design, sales, and research background. Most recent position, U.S.A.F. aircraft procurement project engineer.

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336. Associate Professor—Ten years' teaching and research experience in theoretical and experimental fluid mechanics. Dr. Eng. degree, several publications. Age 30. Would like to join staff of large school. No preference of location.

335. Professor of Aeronautics & Aeronautical Engineer—M.A. (Oxon), B.Sc., F.R.Ae.S., M.I.-B.E. Industrial experience in drawing office, stress office, weight control, detail design, project office, repairs and modifications, maintenance, production, aerodynamic and structural testing and research, flight testing procedure, airworthiness, and general organization of large departments. Positions held as chief of stress, chief technician, research engineer, designer, chief airworthiness engineer. Approved design consultant. Member of various design, research, and airworthiness committees. Author of textbook and various detail design handbooks. Considerable experience in lecturing at London, Bristol, and Oxford Universities. At present, Professor of Aeronautics; responsible for inaugurating new aeronautical engineering departments in aerodynamics, structural design, and aircraft propulsion in two universities. Engaged also as Government consultant to form new airworthiness and inspection departments and to design and construct a number of wind tunnels. Age 44. Replies at this stage to be confidential.

334. Engineering Research Scientist—Age 32. B.S., M.S., Ph.D. Eight years' post-doctorate background with contributions in fields of aero- and hydropropulsion (chemical power, prime movers, turbomachinery). Established and managed applied research division (100 employees) and laboratory with leading national position in field of modern hydropropulsion. Head of task force on unique high-speed propulsion and controls research test vehicle. Consultant to National Research Council (power and propulsion). Desires work with laboratory in engineering research field, including, possibly, nuclear power.

333. Aeronautical Engineer—Thirteen years' experience, structural design, aerodynamics, research, development, and preliminary design for military and commercial aircraft. Desires connection to utilize present available time.

330. Outside Production Supervisor—Has been associated with the industry for more than 20 years. Currently employed in Southwest, wishes to locate in Southern California.

329. Aeronautical Engineer—M.A.Sc., University of Toronto. Age 25, single. Three years' experience on jet aircraft performance, stability and control. "Summer" experience in lofting, weights control, and conversion departments. Class "A," security clearance by RCMP. Desires experience in aircraft aeroelastics. Will relocate.

328. Aeronautical Engineer-Technical Writer—B.Ae.E. degree, 2 years' experience as NATS aircraft maintenance and flight operations officer; author of several technical reports during last 4 years as research aerodynamicist in leading Government aeronautical research organization; private pilot's license; high acumen, responsible, capable of writing lucidly and grammatically. Desires position in which aero-technical background, rhetorical ability, and attention to detail can be fully utilized, preferably on staff of aviation periodical.

326. Graduate Aeronautical Engineer—With several patents and 10 years' experience. Recently developed new all-metal vibration isolator for manufacturer. Has time available for consultation.

324. Engineer—B.S., M.S., B.M.E. Seven years of progressive experience engineering teaching; 3½ years' industrial experience in aeronautical engineering and guided missile work. Strong basic understanding of mathematical and physical problems in engineering. Desires a position on teaching staff or research position with a definite status. Likes to work with fellow workers and students. Will go anywhere, but prefers Texas, California, or Florida. Complete résumé sent upon request.

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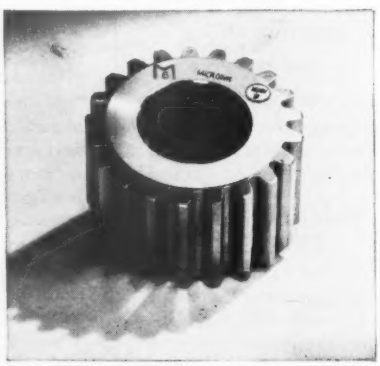

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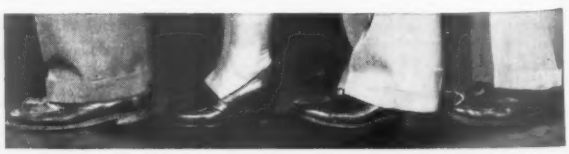

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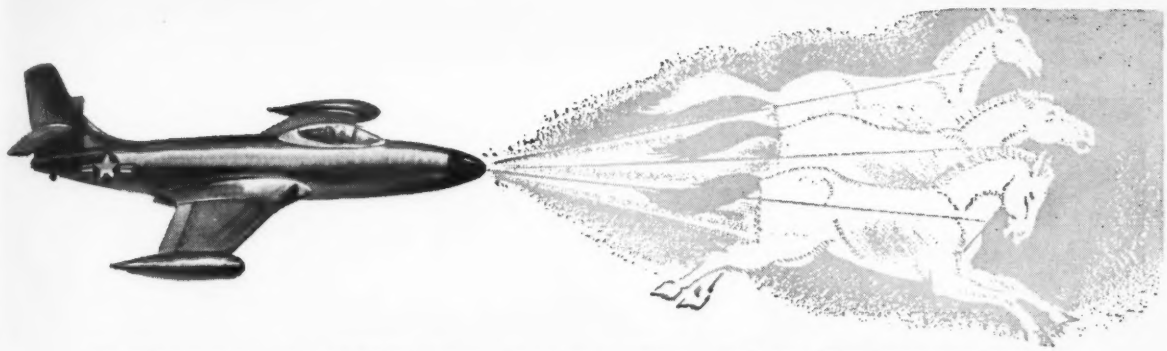

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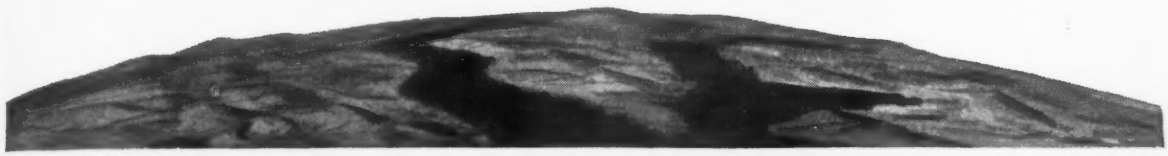

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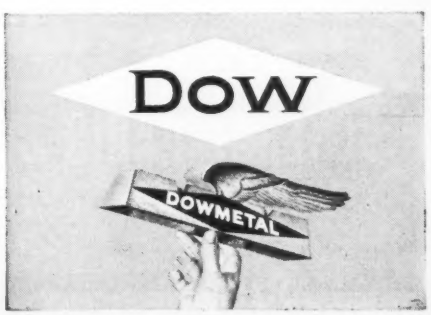

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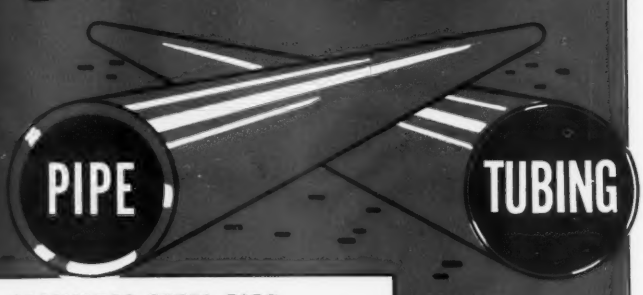

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7/16"	16-25	1 1/4"	10-20
1/2"	14-25	1 3/8"	10-20
9/16"	14-25		
5/8"	14-24	2"	9-20
11/16"	14-24	2 1/8"	9-20
3/4"	13-24	2 1/4"	9-20
13/16"	13-24	2 3/8"	8-20
7/8"	12-23	2 1/2"	8-20
15/16"	12-23	2 5/8"	8-20
		2 3/4"	8-20
1"	11-23	2 7/8"	8-20
1 1/16"	11-22		
1 1/8"	11-22	3"	8-20
1 3/16"	11-22	3 1/4"	8-16
1 1/4"	11-22	3 1/2"	8-16
1 5/16"	11-20	3 3/4"	8-16
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3/8"	.675"	.091"	.065"	—
1/2"	.840"	.109"	.083"	.065"
3/4"	1.050"	.113"	.083"	.065"
1"	1.315"	.133"	.109"	.065"
1 1/4"	1.660"	.140"	.109"	.065"
1 1/2"	1.900"	.145"	.109"	.065"
2"	2.375"	.154"	.109"	.065"
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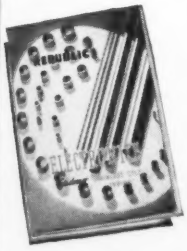

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